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Contents for November

Do You Know 139
Membership Dues ..... *L. E. Grinter* 141
Evaluation of Engineering Education Summary ... 143
Unionization of Professional Personnel ..... *K. B. McEachron, Sr.* 148
Attracting Competent Young Instructors ..... *W. N. Jones* 157
Future Scientists of America Foundation ..... *H. H. Armsby* 159
Instilling Desire for Student Self-Improvement ..... *J. W. Shupe* 165
Mastering the Art of Thinking ..... *K. N. Tong* 169
Young Engineering Teachers' Paper Contest Rules. 170
Engineering Education—Industry's Viewpoint ..... *R. H. Leach* 174
Training in Research ..... *R. L. Pigford* 179
Forecast of Freshmen and Graduates .. *N. N. Barish* 181
Types of Graduate Subsidy ..... *E. Weber* 188
Humanistic-Social Division ..... *S. W. Chapman* 192
Validity of Examinations ..... *I. Wladaver* 197
Minutes of General Council Meeting 205
T-Square Page 210
Candid Comments 212
In Memoriam—H. P. Hammond 214
Report of ECAC Manpower Committee 217
Section Meetings—215 College Notes—156
Sections and Branches—187

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Do You Know—

► The Fall Meeting of the ASEE and ECPD in New York was an outstanding success. The program on "Creative Thinking," sponsored by ECRC and ECAC, dealt with an intriguing subject which certainly needs further exploration. It was highly stimulating to hear the musician, the artist, and the writer discuss the creative thought processes in their respective fields. This is a promising field of development and one which our ASEE groups might well explore for program material. It emphasizes the values to be gained by developing interdisciplinary conferences between the various learned fields.

The Fall Meeting also featured discussions on accreditation of the engineering curricula. There seems to be a unanimity of opinion that the minimum standards of accreditation should be raised in order to achieve an overall improvement in engineering education. The controversial subject dealt with the desirability of special designation for engineering curricula which are particularly meritorious. There seems to be considerable divergence of opinion on this proposal and it is one which certainly deserves very careful study before decisions are made.

If you are wondering why you did not receive an announcement of the Fall Meeting, these announcements were mailed only to the Officers of ASEE Divisions, Committees, Sections and members of the General Council. The complete program was published in the September Issue of the Journal. The Fall Meeting is an outgrowth of closed conferences which were formerly held by the ECRC and ECAC for their Institutional Representatives. The meeting this year served as an excellent opportunity for those who are responsible for planning the activities of ASEE for the coming year to get their planning committees together.

► The Committee on Evaluation of Engineering Education has prepared a preliminary report which was distributed to the Institutional Committees in engineering colleges cooperating with the Committee. Dan Pletta has done an excellent job in preparing this report and it is hoped that the cooperating institutions will study this report carefully and prepare their own comments and recommendations.

You will want to study the proposals of the Committee on Evaluation of Engineering Education summarized on page 169 of this issue of the JOURNAL. This is a condensation of three subcommittee reports which have been sent to the Institutional Committees for criticism. If you have any suggestions, please send them to the Secretary of the Committee, Professor Pletta.

► Tentative plans have been made by the following Divisions to hold Summer Schools either before or immediately after the Annual Meeting at the University of Illinois: Humanistic-Social Division, Mechanical Engineering Division, Mechanics Division, Engineering Economy Committee, Electrical Engineering Division. In addition to these, there is planned a joint meeting of the Instrument Society of America and ASEE, to be held on Saturday, June 12, immediately preceding the Annual Meeting.

This year the General Electric Company will again repeat its Summer School for a select group of young engineering teachers. The Summer School will be held at Schenectady and will feature some

of the instructional methods used in the advanced engineering course at the General Electric Company. This Summer School is co-sponsored by the Educational Methods Division of ASEE.

► The proposal to conduct Summer Institutes was considered by representatives of Divisions and members of the General Council at the time of the Fall Meeting in New York. Two Summer Institute conferences are being planned for the summer of 1954. One of these conferences will explore the subject matter in the area of Solid State Physics; the other will deal with Nuclear Science and Engineering. The objective of these Summer Institutes is to explore some of the newer areas of science and technology in order to obtain an orderly and systematic organization of fundamental concepts as well as to evaluate this material for teaching purposes in the engineering curricula. The tentative plan is to hold a closed conference of from about ten to twenty "experts" in research and teaching for a three to five day period in the Spring of 1954. This conference will lay the groundwork for an open conference to be held during the Summer of 1954. Tentative plans for the Solid State Physics conferences are to hold a closed conference at the University of Illinois and an open conference at Carnegie Institute. For the Nuclear Energy Conference, it is proposed to hold a closed conference at Columbia University and an open conference at Northwestern University. More specific details will be given later.

► The plans for the Annual Meeting are shaping up well. They indicate vigorous activity and promising new fields of development. One feature which is being planned is a joint conference of the Physics Divisions with several of the curricular Divisions of ASEE to thrash out the subject of the teaching of Physics in the engineering curricula. This would include a discussion of the desirability of incorporating in the engineering curricula some of the fundamental concepts in the newer areas of physics, such as nuclear physics, atomic physics and solid state physics. It will also include a discussion of the possibility of achieving integration of subject matter in the physics and engineering courses at the sophomore level.

► An exceedingly promising development is that a number of engineering colleges have now formed their own local YET organizations for young engineering teachers. Young engineering teachers can gain a great deal in depth and breadth of understanding of the engineering profession and engineering teaching by participating in activities of this kind.

Again, let us remind the young engineering teachers of the YET Paper Contest. The rules are published in this issue of the JOURNAL OF ENGINEERING EDUCATION. All entries must be submitted to the ASEE Section Chairmen not later than March 1. Here is an opportunity to gain national distinction. Good luck!

► The ASEE has a number of hot irons in the fire. Watch this column in the months ahead and we will try to keep you informed of the progress. Regards.

ARTHUR BRONWELL,
Secretary

Relation of Membership Dues to the Financial Problems of ASEE

By L. E. GRINTER, *President ASEE*

Your Committee on Society Finances consisting of three past presidents has given careful consideration to the financial stability of ASEE and has made its recommendation for an increase in the dues of all members in its report in the September JOURNAL. I wish to give you my reaction to this report since I consider the raise in dues of any society to be a matter of proper concern to officers and members alike.

The dues of ASEE have been raised from $5.00 to an average of $6.25 in the past twenty years. This is an increase of 25 per cent during a period when even the salaries of teachers have doubled. The Society could not have survived on such low dues if its membership had not been growing. Every administration knows that it is easy to balance an expanding budget, and, as the chart on the Society income published in the September JOURNAL shows, ASEE income has increased from $15,000 a year in 1935 to over $60,000 for 1953. This increase in income is due to a large increase in membership and also to increased advertizing income in the JOURNAL.

Despite the large growth in Society income the cost of serving our expanded membership has gone up so rapidly that a deficit of $1700 occurred during the past year and the budget adopted by the Council anticipates a deficit of $4000 for the current year. This cannot continue or the Society will become bankrupt.

Since I served as a vice-president from 1950 until 1952, I have had to study three or four annual budgets of the Society rather carefully. Our operations are really fantastically economical. We pay no headquarters rental and have almost no physical property. Our Secretary is a part-time professor and his assistant is a full-time professor who devotes only 18 hours a week to our publication work. There are only three full-time employees who are our office secretaries. The total salary cost is less than 50 per cent of that considered normal for societies of comparable size. We badly need another girl in the office for general clerical work, but the Executive Board is unwilling to increase the deficit that we must inevitably suffer this year.

Our expenses besides salaries include $30,000 for publishing the JOURNAL, which is 40 per cent of our income. We are looking into the possibility of reducing this large expense item but the committee that I have appointed to make this study, which includes publisher representatives, is not optimistic that a major saving will be possible. Our other costs include postage, telephone, printed announcements, annual meeting expense, bonding and auditors fee and such dues as the ASEE must pay to ECPD, EJC and American Council on Education. These are essentially fixed costs. The budget includes $2200 for the expenses of ECAC and $4350 for ECRC publications which is largely returned through the sale of the publications. Travel amounts to $4550 which could be reduced. However, it has been the opinion of all Executive Boards on which I have sat that the influence of Engineering Education should be brought to bear upon Engineers Joint Council and other national bodies of a similar

nature by having ASEE represented in as many such discussions as possible.

My analysis of the financial operations of ASEE has led me to the following conclusions:

(1) The Society should continue the association of its national headquarters with a University where space will be available either at no cost or at nominal cost.

(2) A part-time Secretary of professional status is a workable long-term arrangement if adequate secretarial and clerical service is provided. The present salary budget even when increased by one additional clerical worker is desirably low.

(3) Engineering Education requires a monthly publication. Whatever net cost above advertizing income that is involved must be borne by dues income.

(4) All other expenses in the present budget including travel are extremely modest for a society of national standing. In order for Engineering Education to have a sufficient impact upon national professional engineering decisions, a gradual increase in these expenses must be anticipated.

(5) In a small society it is very dangerous to be involved with a fixed income that offers no possibility of expansion to meet inflation or necessary changing expenses. An appropriate body, preferably the General Council, should have authority to adjust dues annually to meet the budget that it considers necessary. It is wise, however, to set an upper limit upon dues, which limit can only be raised by a written ballot of the membership.

The Ballot on Dues. At its meeting on October 15, 1953 the General Council of ASEE decided that a mail ballot should be prepared which, if voted, would make the General Council responsible for setting the dues to provide a balanced budget. The Council recommends that upper limits or ceilings be established of $7.00 for members under 36 years of age and $10.00 for other members. It is proposed that the dues for the first year after approval of the increase by the Society membership be $6.00 for members under 36 years of age and $8.00 for others. The proposal will also specify that the dues should not be increased by more than $1.00 per year after the first year.

I believe that this ballot should be approved by the membership of ASEE. It provides our Society with financial stability for the foreseeable future. It gives to the General Council the full responsibility for maintaining a balanced budget, yet it protects our membership in two ways: first by establishing a ceiling on dues, and second by restricting the dues increase for any member in any year. The proposed By Law represents both justice and wisdom.

Summary of Preliminary Report Committee on Evaluation of Engineering Education

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The Committee on Evaluation of Engineering Education was appointed in May, 1952 by Dean S. C. Hollister, then President of the American Society for Engineering Eucation. The charge to the Committee was to determine the pattern or patterns that engineering education should take to provide the leadership that the profession must have 25 years from now. It had become evident that the tremendous strides taken in the physical sciences during the past decade had begun to influence requirements being placed upon the profession of engineering while only minor adjustments have occurred in engineering education.

As examples of the increased importance of the basic sciences in engineering progress one can point out that electronic developments have demanded greater knowledge of physics from electrical engineers. Such problems as continuity between structural members produced by welding and problems of vibrations of suspension bridges have demonstrated the need for greater scientific background for civil engineers. Mechanical engineers found new fields for research in heat transfer, fluid mechanics and later in jet and rocket propulsion. Practical metallurgy has changed from an art to a science based upon physical chemistry and physics of the solid state. The need for newer reactor materials, new nuclear-thermal processes and new materials and systems for radiation protection add to our picture of the increasing influence of science upon engineering practice. Hence, even without considering the major changes that are inevitable in engineering as nuclear power becomes available, we conclude that the many developments of the past ten or fifteen years would inevitably necessitate major changes in the character of engineering education.

From another direction there comes an even greater influence upon education in engineering. Since 1940 a large percentage of research physicists have had their interests reoriented toward nuclear problems, and it seems doubtful if the interest will ever be returned in sufficient meas-

ure to influence greatly the research in vibrations, elasticity, plasticity, heat transfer, engineering thermodynamics, fluid flow, and the other engineering sciences. Hence, engineers have become responsible for the continuity of research in all the fields of engineering science. The leaders of the engineering profession 25 years hence must be engineers who are at no loss in interpreting or themselves contributing to the extension of the fields of engineering science. Typical curricula of the era 1910–1940 were not designed with such an objective in mind.

Curricula Considerations

Basic Science. The basic sciences for all engineering curricula include mathematics, physics and chemistry. Mathematics through ordinary differential equations seems close to a minimum essential for all engineers. Chemistry deserves increased emphasis in engineering education and for a larger proportion of engineers considerably more than the usual freshman chemistry course is necessary. The Committee has on three occasions indicated its belief that modern physics including nuclear and solid-state physics has become an essential study in engineering. Since the physicists' teaching of mechanics, thermodynamics and electricity is at least partly duplicated in engineering courses, it is believed that better coordination would provide opportunity for the study of modern physics. The Committee, therefore recommends greater emphasis upon basic science in engineering curricula.

Engineering Sciences. The Committee has recognized nine important background sciences in engineering: They are statics; dynamics; strength of materials; fluid flow; thermodynamics; electrical circuits, fields and electronics; heat transfer; engineering materials; and physical metallurgy. It is believed that all of these studies should be represented in curricula that train engineers for service in research, development or design and that probably seven should be integrated into every curriculum that is represented as education for engineers.

Analysis, Design and Engineering Systems. Such studies of the junior and senior years, along with the necessary background of the engineering sciences, represents the features that distinguish engineering education from education in science on the one hand or technical institute education on the other. In all curricula except those intended for training in management or other general professional service, studies in design, or in analysis leading to design, should occur as an integrated study over four successive semesters. Even the most general curricula should include such studies as a continuing program for at least two semesters.

Non-Departmental Engineering Courses. Curricula often contain certain engineering courses selected for broadening purposes such as electrical engineering for non-electricals and heat engines for non-mechanicals. When given, such courses should limit the study of special machines or devices including their construction, production or operation. The Committee affirms its conviction that the most important broadening courses in engineering are those listed as the engineering sciences.

Humanistic-Social Studies. The Committee recognizes the importance of social studies and the humanities as an important part of an engineer's education. Such studies reveal the richness of human experience so that students may in turn enrich their own lives. They should trace the political, economic and social history of mankind to give students a clearer perspective of our civilization today. They should provide inspiration for seeking greater knowledge and understanding They should aid the student to develop judgment and discrimination, a sense of value, and a sound personal philosophy.

The seeking for immediate usefulness in the social studies and humanities, as tool subjects in engineering, may well lead to failure to achieve the objectives set forth

above. Such courses as accounting, industrial psychology, investment economics comparative costs, or city management may be just as technical as engineering studies. It is outside of such fields that the social-humanistic studies must lead the student. The Committee recommends a much broader study of the effectiveness of the social-humanistic stem of engineering education.

Faculty Selection and Development

Since a more scientific approach to engineering education is needed it will be essential to improve the scientific background of engineering faculties. Within a given faculty there should exist a balance of experience in both the science and art of engineering. An educational background which includes the Ph.D. degree is the strongest evidence usually available to measure the probable usefulness in teaching and research of a relatively young candidate for a faculty position. For older persons evidence of the productivity of the individual in creative teaching and research may be gaged by other criteria, and the formal educational background is of less significance.

Engineering education cannot develop superior students without developing superior teachers who will be recognized as creative leaders in the fields in which they teach. A faculty that can be expected to provide adequate leadership for students will have at least one member in five who has achieved professional distinction by creative activities. Such persons will (1) be conducting high grade research of an engineering or educational nature or other creative activity including publishing of good quality, (2) be engaging in consulting work at a creative level, (3) be exercising leadership in scientific, educational and professional societies or (4) preferably be serving in a combination of such activities. It is recognized that development is quite as important as selection of a faculty and also that a definite policy on termination of employment for those who do not live up to their expected performance is a necessary factor in faculty development.

Accreditation of Curricula

A request from ECPD brought the Committee on Evaluation into the discussion of accreditation. For proper handling of accreditation ECPD needs improved standards for measuring the effectiveness of the educational process and also criteria that distinguish engineering curricula from those in science and from those in technical institutes. As already indicated the Committee on Evaluation concluded that an increased background in mathematics, physics and chemistry, a study of nine engineering sciences, and a continuity of study of engineering analysis and design, or of engineering systems, extending through four semesters should distinguish an engineering curriculum intended for the training of engineers for professional-scientific service such as research, development or design. Then recognizing the need for additional engineers for general professional engineering services, the Committee concluded that a bifurcation in engineering education is the practical answer to such diverging functional objectives. It has, therefore, suggested the terms *professional-scientific* programs and *professional-general* programs to designate the two broad functional objectives of engineering education.

Professional-general programs are those designed for producing engineers qualified (1) to serve in areas between engineering and business, management, law, real estate, or agriculture, (2) between engineering and a branch of science where the opportunities to apply engineering analysis and design may be limited, (3) between engineering and a highly applied technology such as production processes, operation, construction, or air conditioning, welding, or wood technology. Such programs may have somewhat reduced requirements of mathematics, physics and chemistry, and only seven of the nine engineering sciences need be included. Also, the study of engineering analysis

and design may be reduced from four to two continuous semesters. However, the decision as to whether a planned program curriculum is really engineering education is to be made wholly upon its content of the engineering sciences and the use made thereof in the study of engineering analysis, design and engineering systems.

A decision has been reached by ECPD, upon the recommendation of the Council of ASEE, that the standards of accreditation of engineering curricula shall be raised. To achieve this result without undue hardship it is here recommended that the accreditation process be reconsidered on the basis of a distinction between *professional-scientific* studies and *professional-general* studies. Some institutions may choose one function or the other for all programs; other institutions may have a bifurcation between the objectives selected by different departments; and in large departments dual curricula serving different functions may develop. Bifurcation exists widely today in upper-division options, senior options, groups of electives or selective opportunity for research or thesis study. The Committee emphasizes the importance of broad experimentation with all such opportunities for selected engineering students. Each device mentioned can make a strong contribution to professional-scientific study.

The Committee on Evaluation recommends that each engineering college determine for itself the best way to meet ether or both of the dual objectives that the Committee has defined for engineering education. To ECPD it recommends liberal acceptance of experimental programs that meet the definition given of engineering education, i.e., those that include an adequate content of engineering science and of applications thereof to engineering analysis and design. The length of curricula should be one such factor subject to wide experimentation. The Committee does foresee difficulty in meeting within a four-year program its recommendations for an accredited professional-scientific engineering program plus all of the specialized courses of the degree-granting department, but it believes that specialized engineering courses are of far less value in professional-scientific education than a broad background of engineering science and its application is one field of analysis and design.

Special Designation of Accredited Curricula

There appears merit in identifying those curricula which meet criteria substantially above the minima. The major factor in such identification should be the background and eminence of the faculty and its attention to creative teaching. When the program conducted by this faculty is of such a nature as to develop in a considerable proportion of the graduates a capacity for creative technical activity or creative leadership in engineering it is the recommendation of Committee that this curriculum should be given special designation. For such designation curricula should be taught by faculties including a substantially larger proportion of distinguished staff members, as defined previously, than is required for minimum accreditation. The recommendation of a curriculum for special designation should be referred by the Inspection Committee for final action to a group of national representatives whose background of examination of institutions covers a wide geographical area.

Conclusions

1. By joint action of ASEE and ECPD the Education Committee of ECPD has been instructed to develop higher standards for accreditation of engineering curricula.

2. One objective of the Committee on Evaluation has been to establish a philosophy of engineering education appropriate to the training of engineers for leadership a generation hence, and to clarify the significant factors that contribute to high standards of engineering education.

3. Another objective has been to study the influence of higher standards of ac-

creditation upon the Engineering Colleges and to consider ways in which institutions may appropriately justify accreditation based upon the performance of different functions in the broad field of engineering education if they so desire.

4. The functional divergence so evident in engineering activities, which range from research to management and sales, has led to the Committee's recommendation that accreditation be based upon either of two defined functions in engineering education, i.e., *professional-general* education and *professional-scientific* education. Such divergence should not necessarily require separate curricula but might be based upon options, groups of electives, their study, etc.

5. In order that the decision to develop advanced standards of accreditation may not unduly restrict the number of possible accredited curricula, the Committee recommends that a special designation be given to any curriculum taught by a faculty of unusual distinction where the program conducted by the faculty is of such a nature as to develop in a considerable proportion of the graduates a capacity for creative technical activity or creative leadership in engineering.

Further Studies

The Committee on Evaluation has made the report summarized above as a *Preliminary Report* for study by each College of Engineering. Each of the recommendations tentatively adopted will be reconsidered in the light of the suggestions, criticisms and revisions presented by reports from Institutional Committees on Evaluation and Deans of Engineering Colleges. Resolutions from engineering groups will be welcomed although mere criticism or approbation without supporting analyses will not be very helpful to the Committee in revising its report into final form. Therefore, the Committee on Evaluation particularly requests thoughtful, mature analyses of the Preliminary Report without undue emphasis upon the form or mechanism of accreditation which is of secondary importance in this study.

Unionization of Professional Personnel*

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I shall endeavor to discuss this subject from the point of view of industry as I see it. Obviously I cannot speak for industry as a whole nor will the point of view which I give necessarily represent the complete and entire point of view of any manufacturer or groups of manufacturers, or employers of professional personnel. Since industry employs both engineers and scientists in many of its operations, very often in the same plant, it is proper to consider them together, although the chief emphasis will be on the engineers.

The Struggle for Unity Organization

There has long been an urge on the part of engineers and scientists to find some way to keep governmental agencies properly informed as to the advances in the fields of science and engineering. The professions of law and medicine exert a strong influence on governmental affairs as applied to their own spheres of activity. The engineers and scientists as a group possess special knowledge which they feel can be useful to the government at local, state and national levels and it is to be expected that the professional man will want to assist government to whatever degree he can.

On the other hand, there are matters of legislation of very considerable importance to professional people which with the exception of law and medicine, and to some degree the church, have not been well represented in the halls of Congress. It is well known that legislation affecting the practice of medicine will have the scrutiny of the Medical Association before it gets very far.

Beginning with the formation of the American Association of Engineers in 1915, there have been several organizations formed to work in the fields of activity covering all branches of engineering. These included American Engineering Council, the Engineering Council for Professional Development, and more recently the Engineers Joint Council. The Founder Societies were active in the formation of all of these. The AEC was in existence for eighteen years.

The objectives of EJC, which now has a membership of eight National Societies, including the Founder Societies, are:

"a. Advance the general welfare of mankind through the available resources and creative ability of the engineering profession.
b. Promote cooperation among the various branches of the engineering profession.
c. Advance the science and profession of engineering.
d. Develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful through the services of the members of the engineering profession."

Registered Professional Engineers in the various States founded the National Society of Professional Engineers in 1934 with headquarters in Washington, D. C. Its voting membership is limited to those registered under the laws of the various

* Condensation of paper presented at the Annual Meeting, ASEE, Univ. of Florida.

States. Its objectives are given as "the advancement of the public welfare and the promotion of the professional, social and economic interests of the professional engineer." It has presently a membership of 28,000. Members are kept currently informed of activities through the N.S.P.E. Legislative Bulletins, and their publication *The American Engineer.*

Of this entire group, the two organizations who stand out most clearly today as being possible vehicles for meeting the objectives of the unity organization, are the National Society of Professional Engineers and the Engineers Joint Council. Neither of these organizations quite meets the desires of engineering people, which may be summed up in the following:

IMPROVE { Professional / Economic / Social } status

PROMOTE { interests of their employer or client / interests of their profession / general welfare of the professional employees }

SERVE { their community / society at large }

REPRESENT { engineering and scientific people in problems of local, state and national government }

Growth of Engineering Associations and of Independent Unions

After the Wagner Act (1935) and before the Taft-Hartley Act (1947), many professional persons became increasingly alarmed over the possibility of finding themselves in a heterogeneous union in which the professional people would be greatly outnumbered and persons controlling the union would not be likely to be sympathetic to problems of professional people. What could happen was demonstrated in many cases as documented by Raymond L. Forshay in a paper in 1946 presented to the ASME.

Engineering Associations (Non-certified)

The most extensive organizations of Engineering Associations which are not union groups are found in six of the larger plants of the General Electric Company, with a total membership of almost 4000. In the G.E. Associations, engineers at all levels may become members but those in supervisory or managerial positions do not in general take any active part. Generally speaking, their constitutions provide for "an organization through which the members may advance their professional, economic and social status and better discharge their responsibility to promote the interests of their employing company and their profession, and to serve their community and society at large." The largest of the Associations, which is in Schenectady, has been very active in promoting civic activities such as a housing project, traffic control, transportation and many other matters which have been of distinct benefit to the city of Schenectady.

There are associations in other companies which have objectives that are similar.

These Associations have in general kept their members informed of the salary situation through salary surveys and have also provided useful data resulting from attitude surveys which some of them have conducted. The ideas of the General Electric Associations on Unity have been incorporated in an article appearing in *Electrical Engineering* for April 1953, entitled "A New Unity Plan Proposed."

Unions Set up for Protection

Perhaps typical of the unions formed to prevent being drawn into a heterogeneous group are the unions organized at the Western Electric Kearny Plant, TVA and Sperry Gyroscope. Some of the unions so organized still retain their autonomy while others have joined the newly organized Engineers and Scientists of America, which is now on a National basis. Some have operated very much as they did before they were certified. Others

have been more militant in their dealings with their managements, operating to negotiate grievances and using the machinery which is normally associated with labor unions. This was, of course, a natural development even though organized originally as a protection against a labor union.

Unions Set up for Bargaining Purposes

Unions in this category were established primarily because of what they regarded as being unsatisfactory practices of the employers. Some of the practices listed as being unsatisfactory are: Loss of economic position in comparison with labor; no premium pay for overtime; too little personal recognition by supervisors; use of engineers for semi-technical jobs; lack of planning for the development of young engineers to increase their effectiveness and to utilize their particular talents; inadequate measures taken to prevent loss of dignity and failure to maintain professional standing; failure to provide adequate channels of two-way communication; inadequate and undesirable offices; lack of secretarial and drafting assistance; punching clocks; checking by plant guards when coming in late.

Situation is Greatly Improved

Many companies have given much time and effort to determine what is right and proper in terms of compensation, job satisfaction, dignity, professional recognition, opportunity for position development, clear understanding of mutual problems, better two-way communication, use of professional personnel up to their full capacity, further development of individuals through courses both within and outside the Plant, together with proper facilities for doing the work assigned. These, together with realistic and satisfying insurance, pension, investment and savings plans, as well as freedom from unnecessary restraints, are designed to relieve the professional employee from frustrations and worry so he can do his best work and progress as far as his ability and desire can take him. These are the goals of enlightened industry today with respect to their professional personnel.

In industry whose product is such that the engineering content is great, the supervisors and managers are usually engineers themselves, and have the engineering approach and point of view. The EJC Survey of 1946 indicated that over 30% of the technical graduates reported their field of employment as either in administration or management. There is a wealth of other data indicating that engineers are widely used in managerial positions. In such enterprises the professional will also be found in the manufacturing and marketing operations. Thus the engineer, either through the developments he may make, the new and novel designs he produces or the new molecule of which the scientist may be the architect, may well have such an important effect on the business that he truly becomes a part of management although he himself may not be a manager or even a supervisor.

How can the engineer be taken into the confidence of management with reference to problems where the engineer's knowledge or judgment is important to the business, if the manager knows that such information could be of great value to a union for propaganda or bargaining purposes? This cannot help but build a wall between the professional personnel and their management. When the union is a local and independent one this may not be a serious matter, but for confidential information to become available to National union leadership who have no particular sense of loyalty to a given plant, and who may even be antagonistic to its management, would be most unfortunate. Under such conditions management would tend to protect itself by not taking its personnel into its confidence as it normally can do with its professional people when they do not belong to a National union. There are engineers in employments where the above statements do not apply because they are not consulted on

policy matters or their work is of such a nature that they do not have access to confidential matters. In some cases it will not apply to young engineers until they have established some reputation for accomplishment.

Ethics

The engineers no more than the doctor or lawyer can serve two masters. Like the doctors and the lawyers the engineers and scientists are a group of intelligent people capable of speaking for themselves and disliking regimentation or compulsion. They believe that the treatment accorded them should be like that given to doctors and lawyers, and they are right. On the other hand, they must show that they are worthy of the trust placed in them, and that they will conduct themselves in a manner befitting a professional man who places the interest of his client or patient first and who will do nothing while employed by him to hurt his interests. The professional knows, or should know, that no business can prosper without profit—that a reasonable and proper amount of money should be reinvested in the enterprise in order to retain a satisfactory percentage of the available business. He knows also that the product must be improved continually, new products developed and cost reductions achieved constantly; otherwise the company will go out of business. These are matters of economic operation and along with other items are the concern of the engineer. It is his responsibility in many companies to maintain the quality of the product and to assist materially in reducing complaints. He must do all he can to protect the interests of his company in design, in manufacturing, in the marketplace, or wherever he may be.

Ethical practice may be difficult within a local independent union, or association as they are frequently called, but with a National union the opportunity and temptation for unethical practice will become even greater, particularly where competing company employees are concerned, or customers' and vendors' employees are involved. The engineer is often entrusted with developmental information relating to new products or improvement of existing ones which may be of very great value to his company, and where premature disclosure could have disastrous effects. Such information is the property of the employer and should not be disclosed nor should it be a matter of or related to any bargaining issue. There are many problems to be solved in this area by the national union when it has in engineers and scientists from all kinds of industry, together with a smaller percentage of nontechnical people. This is not to state that the National union cannot be ethical or that it is inherently unethical, but it is to say that as more and more power is concentrated at the top the stakes become higher and the temptation greater to feel that the ends justify the means.

Effect on Technical Societies

The effect will be determined to a considerable degree by the future growth of Engineers and Scientists of America (ESA) or equivalent union, and the changes the unions or technical societies may undergo as a result of experience and the passage of time.

The injection of another national organization (ESA) with the stated objective "to promote the economic, professional and social welfare of engineering and scientific employees" adds to the already complicated picture of unity organizations.

Since ESA is a union group it is different from any of the other societies in that it automatically excludes managers and supervisors from its membership. It is also different in that scientists are included. It is to be noted in this connection that engineers and scientists are often employed in the same laboratory or plant. However, many scientists belong to the engineering technical societies because of a community of interest in certain fields. Scientists are included in the membership of both union and nonunion associations in many locations.

The stated objectives of ESA are very similar in essence to those of the American Association of Engineers and the National Society of Professional Engineers except that ESA is limited to employees. ESA has in its scope some of the functions of the EJC.

It would appear, based on objectives, that EJC, NSPE and ESA are all in a somewhat competitive position with respect to legislation as it affects the engineers. This applies in areas outside the strictly technical.

Those who have the welfare of engineers and scientists at heart should make it their business to give this whole matter serious and unbiased study, because trends may be established now which could not be changed a few years hence. Let's be sure of how we want this unity program to develop. There are those who would combine all activities in one society, to avoid duplication of effort, payment of dues in two or more societies and to avoid attending several sets of meetings in order to get the complete program.

Some of the difficulties of operation with groups more or less in competition is indicated when one considers the operation of committees in the technical societies or National Society of Professional Engineers who may have in their membership persons who are also active in ESA, thus making the problems of living together increasingly difficult. This could result in supplying channels of information either into the technical societies or into ESA which might be used in a manner inimical to the interests of the groups involved.

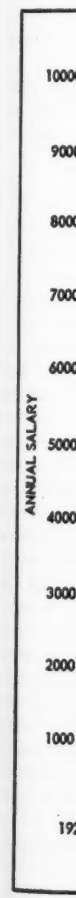
Professional Employee Relations

In this paper there will be no attempt to present a complete story dealing with all the problems of management with respect to the professional employees. Some of the more important ones, however, will be discussed briefly.

Whether in our colleges or universities, in industry or in government, to produce job satisfaction on the part of the employee it is necessary that his management not only understand but practice good professional relations. Job satisfaction includes many factors, one of great importance being compensation. In this brief discussion of compensation I will limit myself to the problem as it exists in industry.

The larger enterprises, and many of the smaller ones, who are concerned about their professional people have given a great deal of time and effort to setting up salary policies which will be fair and just, with all determining factors considered. The compensation which a new professional employee without previous service receives is necessarily a payment for potential. As the years pass, however, the compensation is based to an increasing degree upon his demonstrated contribution. Obviously the contribution which a man may make to the operations carried on by his company can and in many cases does continue to increase through the years as long as he remains with the company. On the other hand, it does not necessarily follow that because he is older his contribution is greater. In many companies, salary reviews are conducted at stated intervals, perhaps once a year, after having made a careful appraisal of each individual and his accomplishment, but it should be possible to make salary adjustments whenever warranted in special cases.

Survey data such as in the 1946 Survey made by EJC, and other surveys made by groups of employers or by technical societies, as NSPE or the various Engineering Associations are useful and should be properly consulted and compared with the salary structure in a given company. It is important to be as sure as one can be that the compensation is right and proper for the individual involved, with due consideration being given to the compensation received by others in his own group, or in other groups requiring similar skill or experience in his own company, as well as comparison with data received from outside. The professional



employee feels that a merit increase is a measure of his improved performance, his better output or his ability to handle increased and more complex work, and is given to him in recognition by his employer of this improvement. Increases that come to him as a result of other factors which may be general increases not based on merit are, of course, very acceptable and if not received would be cause for complaint.

Some sort of rating system or its equivalent has proven to be very helpful in the matter of appraising an individual. It also provides a good opportunity for his supervisor to discuss with him his opportunities for advancement, his contributions, his personal qualifications and

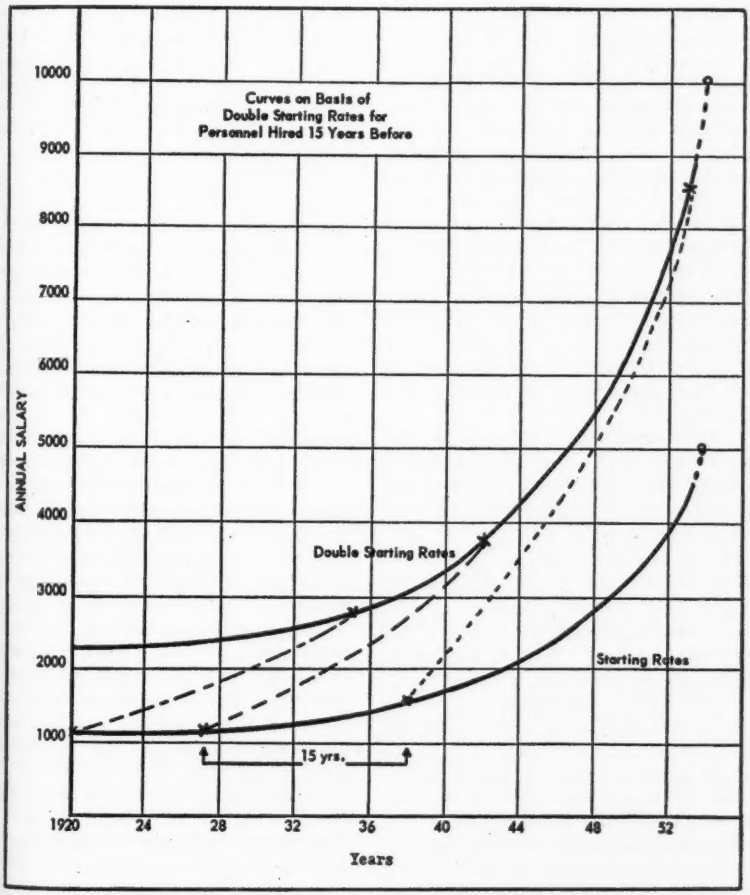


FIG. 1. Starting rates for engineers—showing curve of increase when salary is twice the present starting rates after fifteen years of service.

any unsatisfactory situations which may have arisen, and to indicate to the employee what he himself might do, and what the company might help him do to improve the situation. Such interviews should be conducted frequently. The supervisor and the employee should welcome the opportunity for a heart-to-heart talk concerning any matter which is on the mind of the employee, but aimed particularly at the employee's question "How am I doing?" This does not mean that the contact should be limited in any sense. The professional employee should always feel that his supervision will be glad to talk matters over with him at any time, whether in the field of his own personal affairs, his relationship to the company, his prospects for the future or any other matter. It is not enough that the supervisor merely be able to call the professional employee by his first name and to make it easy to have an interview, but he should be sure that the employee understands that his supervisor has a real and personal interest in his happiness and well-being. He must be willing to demonstrate this attitude in his actions as a supervisor.

In connection with compensation, the curves shown in Fig. 1 are of considerable interest. The lower curve shows the starting rates for B.S. graduates beginning in 1920 and projected to 1954. Up to 1953 this is an experience curve. Whether or not it will continue to the point shown for 1954 is, of course, unknown, but it is rather amazing to note how these starting rates have increased. Bearing in mind the present economic picture in our country, one could hardly expect that the starting rates could continue to increase in the same fashion as they have done in the last ten or more years. It has been suggested in various places that a criterion for determining the present salary of a professional man could be on the basis of at least twice the present starting rate for a man who has had fifteen to twenty years service. To see how this works out the upper curve was drawn in Fig. 1 on the basis of indicating double the starting rates throughout the entire period. Curves have then been drawn showing a possible salary increase picture for an individual who entered employ in 1938 and in 1953 would be expected to receive at least twice 1953 starting rate. The curve for such an individual is almost asymptotic. It will be immediately apparent that such a situation is unstable and certainly cannot be expected to continue very long without reaching some rather astronomical figures. I am not making any predictions whatsoever as to the future, but I think it is clear that these figures cannot continue to rise at the increasing rates of the past without the economy being seriously affected.

Two-way Communication

The channel of communication between the employee and his supervision must be kept open. First the employee must know what is expected of him. He must be properly oriented with respect to his supervision and his fellow employees. He should be kept well informed of the company's procedures, practices and policies, and how they affect him. His questions should be answered directly and immediately by the supervisor, and if he does not know the answers they should be secured within a reasonable period of time. The potentialities of the man should be given every opportunity to develop to the fullest and he should be appraised frequently of the progress he is making. Worthy goals should be set up for him to strive for, and then proper recognition given both in compensation and in position. In highly specialized operations there will be need for the specialist whose compensation, position and professional standing should be commensurate with his contribution to the success of the business as well as in the improvement in the art. Policies with reference to improving his education in those areas which are of mutual value to the company and the employee should be given very careful consideration and where arrangements can be

made reasonably, this should be done in a manner satisfactory to both employer and employee.

Some people work well under pressure and others may not. The idea that developments may be scheduled with exactness would depend upon the state of the art and what might be the nature of the development. There has been recognition of this in the separation of the scientific personnel engaged in purely scientific research from personnel primarily concerned with production. This does not mean that goals should not be set up and dates attached, but supervision ought to understand and be sympathetic to reasonable operation for the scientific personnel.

More and more professional people work as teams or task forces to solve the problem, because the background has in many cases become so great that one individual cannot be sufficiently expert in the many fields involved. Design problems are much closer to production—dates and specifications must be met. The engineers must be able to work with the customers in many cases, with the manufacturing organization, sales or marketing groups and produce a design on which the employer can make a reasonable profit. Such factors as these are all important to the operation of the business and must be discussed frankly and freely with employees, through the medium of two-way communication. The employee will get the sense of belonging to the company if he is taken into confidence and informed of impending changes which may even remotely affect him or his operations. This can be done individually or collectively with groups, depending upon the nature of the problem. Many companies today are holding informative meetings frequently, sometimes in large groups when dealing with overall company business problems and matters of that sort, and even more often in smaller groups when the problem being discussed is one of a local nature or one which requires more intimate contact with the engineers and scientists.

Activities of this sort take considerable time and they have to be reasonably well planned. Yet they do make for good job satisfaction. I know engineers who have been employed for periods as long as five years to whom their company's plan for insurance or pension has never been explained; neither have they received any written material relating to it. Many companies are doing a good job in this area, but it is an important field and should be given very serious attention.

Summary

1. There has been a strong desire on the part of the engineers during the past 30 to 40 years for the development of an organization which can speak for them in relation to government, which will do whatever is necessary to maintain the professional standing of the profession, set up in such a manner that its members may feel a personal and active relationship to such a unity organization, with an operating mechanism which is reasonably quick and will represent all engineers of every branch in all matters of concern to the engineers.

2. The growth of the Engineers and Scientists of America, which is a federation of labor unions, represents the entrance of another group into the unity picture, and its possible relationship to existing technical societies, groups like NSPE, AAE and Engineering Associations requires very careful study and consideration. People in these various groups will be interested in studying this whole situation to discover what these trends mean and what future action ought to be taken to get the best result. If ESA grows to large proportions it can constitute a serious threat to the existing Societies.

3. The existence of a national trade union of engineers for the purpose of collective bargaining, using the usual union pressure techniques, is almost certain to produce profound changes in the professional status of engineers if the venture is successful. While there are isolated small and exceptional instances

of trade union organizations in other professions the trade union principles of militant, collective action are in many respects inconsistent with the principles of the professional engineer, doctor or lawyer which emphasizes individual competence, integrity, and the confidential relation between the professional and his client or employer.

4. There are many situations in existence today in the various employments in industry, in government and in our educational institutions where professional employees are not being given the consideration now being thought desirable and necessary by the more enlightened industry units. The following thoughts may be of value to you in this direction:

a. Be sure that you are giving your engineering and scientific personnel compensation which is just and fair, and be certain that you are familiar with what others are doing in this area as a check against your own thinking.

b. Give your professional people the attention which they and their problems deserve.

c. You cannot operate in a vacuum—your communications must be good both ways. Your supervision may not be as good as you think.

d. Avoid misunderstandings. Be sure that your supervision has a clear understanding of his own responsibilities and accountability.

e. Realize that your professional employee wants recognition not only from the salary or compensation point of view but as a professional individual who carries a real responsibility and who in many cases can grow in his contribution if given the chance and backed up with faith and willingness to help on the part of an immediate supervisor. To be as successful as we can be, we should continually strive for job satisfaction. Be certain that your professional people are used up to their capabilities, that their contribution and potential is properly evaluated, that the employee is kept informed, and that his compensation is right and proper both from the standpoint of his own group and company as well as on a community and national basis.

College Notes

Paul F. Chenea has been named as Assistant Dean of the five engineering schools of **Purdue University.** In his new capacity, Dr. Chenea will assume such administrative duties as may be assigned by G. A. Hawkins who became Dean last July 1.

* * *

George Gerard has been appointed Assistant Director of the Research Divisions of **New York University's** College of Engineering. The Research Division, with a staff of 405, has an annual operating rate of more than $2,000,000 in research sponsored by industry and government. . . . Emanuel A. Salma has been appointed Acting Director of the Evening Division of the College of Engineering at **New York University.** He will administer the educational programs of 1,130 students who are studying for degrees in major branches of engineering while employed in engineering work during the day.

* * *

The **University of Pittsburgh** has let contracts totalling $1,195,087 for the construction of a building to be a new headquarters for its schools of engineering and mines.

How Can Competent Young Instructors Be Attracted to Colleges? What Intangible Rewards Are Available?*

By WEBSTER N. JONES

Vice President, Carnegie Institute of Technology

One of the critical problems that continually haunts engineering college administrators is how competent young engineers can be attracted to teaching, and as a corollary, what intangible rewards may be stressed in lieu of high salary.

First on my list of criteria for attracting good teachers, I would place leadership—the need for an enlightened, progressive and respected central administration, dean, and department heads. There is no need to spell out the reasons why good leadership is essential; I'm sure you all agree with me on that point. But I would like to interject one word of caution. In so far as may be possible and practicable, I would warn against too frequent turnover at the department head level. It takes a long time to develop a good department head, and a longer time for him to develop the type of intimate morale which goes beyond what can be found in industry and makes membership in his department appeal to the finest type of young man. Many faculty members just do not have the required abilities to be an administrator, as well as to direct and take part in teaching and research. In any case, I would recommend that department heads be appointed rather than be elected by their colleagues at recurring intervals.

Secondly, I would be concerned with educational objectives, and the general policies and procedures used to achieve them. If a man is to give up the greater financial rewards of industry, one of the strongest reasons for doing so will be his love of teaching, and his faith that in the institution where he will teach, teaching can be made enjoyable and deeply worthwhile—a greater service to his country than he could give in any other way or any other institution. "Sound educational objectives" implies preparing the student to continue to learn for the rest of his life as a person, a citizen, and a professional man; and although there may be many satisfactory routes to achieve these objectives, few promising young teachers will be attracted by a philosophy of stuffing the student with knowledge and techniques as contrasted with the philosophy of educating the young to become better.

Assuming that we are talking about an institution that is primarily undergraduate, I would nevertheless insist on having a quality graduate program and the vitalizing influence of research. Every staff member must in general expect to share the opportunity to teach graduate courses and direct research in his field of special interest, so that he can find a higher intellectual satisfaction at the cutting edge of progress in his field than industry can provide. Of course, the faculty member should also be encouraged to participate in part-time consulting work, and in the activities of technical and professional societies.

*Presented at the Annual Meeting of ASEE, University of Florida, ECAC Program, June 1953.

Character of Staff

Next in importance, I think, concerns the character or make-up of the existing staff. The most valuable natural resource of any organization, and perhaps its greatest source of pleasure and development, is the young engineer who comes to it. Indeed, to many a man in industry, the primary appeal of the educational institution is the intellectual personal quality of its staff members. A young man wants to be stimulated by competent leaders in his field, and he wants to work in an environment that encourages his professional development, and that also delights him by the human contacts it provides.

Then *fourth,* I would want adequate space and equipment. It is all too easy to give lip-service to the necessity for research, and yet not provide the facilities that are required to do the job. True, graduate work and research are expensive. Yet they must be done, if only to improve the quality of the undergraduate education. Enlightened leadership will find ways to provide the space needed for research and adequate equipment, too. The expense can be minimized through a carefully planned and administered program of sponsored research. And much good fundamental research can be carried out in existing undergraduate laboratories.

Fifth, though not necessarily last, adequate salaries must be paid, especially for outstanding men. The generally prevailing rates of faculty compensation are dismally low compared with salaries paid by industry to comparable personnel. I doubt if there are any schools that have been able to keep their salaries moving with the increased cost of living in the past ten or fifteen years. We must do much more, if we are not to lose our best people to industry. Fortunately, there will always be those who will prefer the university atmosphere and the attendant advantages and opportunities. But that is no excuse for holding salaries down, and it cannot be relied on without danger, especially of losing the best men. Every effort should be made to pay better and better salaries, and to avoid routine personnel attitudes that lead to even rates of promotion. Instead, education must equal or surpass industry in recognizing and advancing rapidly its key men. They are the ones to fight for. "The poor (and even the merely competent) we will have with us always."

Conclusion

There may be other factors which contribute to the appeal of an educational institution—for instance the quality of the students admitted—but I think in essence we have mentioned the most important. Of this I am sure—if the institution has good leadership, if it has sound educational objectives and standards, if it has a highly competent staff, if it has ample facilities and pays adequate salaries to good men and outstanding salaries to the best no matter how young, then it will have less difficulty in attracting new faculty members of outstanding promise and in keeping them.

Future Scientists of America Foundation—Its Work and Objectives*

By HENRY H. ARMSBY

Member of Administrative Committee FSAF

Before this audience of engineering educators and employers of engineers, there is no need to call attention to the current and prospective shortage of engineers, scientists, and technicians. You all are thoroughly familiar with the various estimates which have been made, which, while they differ in detail, are all in agreement that the shortage is a serious one, and that it can be expected to continue for many years.

A *New Forecast of Engineering Graduates*

In my latest attempt at forecasting numbers of engineering graduates, prepared for a recent meeting sponsored by the Research and Development Board, I computed engineering freshmen as a percentage of all college freshmen, and found that the percentage reached a 20 year low of 6.6 per cent in 1950. Last fall it was 9.7 per cent, compared to a general 20 year average of 8.0 per cent. If we can maintain the 8 per cent ratio, the increasing sizes of the groups of young persons reaching college age should yield, according to my estimates, from 26 to 30 thousand engineering graduates per year beginning in 1956, when the present freshmen class graduates, provided no basic changes are made in Selective Service policies or in other basic factors affecting enrollments.

*Talk delivered before the General Session of the American Society for Engineering Education, Gainesville, Florida, June 25, 1953.

Probable Civilian Supply

These are estimated total engineering graduates, but the inroads of Selective Service and ROTC programs will leave only a fraction of this number available for civilian employment.

Last fall I served as a member of a subcommittee of the ASEE Manpower Committee which attempted to estimate the number of engineering graduates who would be available for industrial employment through the period 1951–56 under two alternate assumptions; (1) a continuation of present conditions of partial mobilization, and (2) all-out war in 1954. We estimated about 118 thousand available under present conditions, and 31 thousand under all-out war in 1954. At the BLS "partial mobilization" rate of 30 thousand per year, the total need for the six-year period will be 180 thousand. What it will be under all-out war conditions no one knows, but certainly it will be much larger.

The second annual report of the National Science Foundation contrasts this picture with their best estimate of conditions in Russia. According to this report, the USSR has enjoyed a steady climb since 1945 in the production of engineers, and their plans call for 50 thousand a year by 1955. Furthermore, these Russian engineers are for the most part graduates of five-year curriculums, and some of six-year programs.

A Long Range Program Indicated

These few figures are given to indicate part of the reason for the establishment

of the Future Scientists of America Foundation. Even a brief study of the figures indicates that the problem of the shortage cannot be solved at the college level alone. Anything done at this level can be only a short range and partial answer. The long range problem can be solved only by considering high school youth, especially those still uncertain about future careers but possessing aptitudes and abilities indicating probable success as scientists, engineers, or technicians. The problem then becomes one of identifying the students with these abilities and aptitudes, giving them sound and unbiased career information, using effective motivation so that they may seek to make the most of their native abilities, and providing such instruction in junior and senior high schools as will give these youth the proper foundation for successful study of engineering, science, or technology in colleges or technical institutes.

The importance of this kind of a program can be appreciated when we realize that approximately 40 per cent of those high school graduates who have the ability to do successful college work (the top 15 per cent of the total high school population) do not go to college at all. If some of these capable students can be helped to consider seriously their own abilities and interests in relation to the Nation's needs for scientists, engineers, technicians, and science teachers, then the general situation in these fields can be improved without endangering the development of manpower for other fields. More and more leaders working on manpower problems are accepting the idea that special efforts to improve and expand the teaching of science and mathematics in junior and senior high schools are greatly to be desired.

The May 1951 Institute sponsored by the Thomas Alva Edison Foundation brought this critical situation to the attention of leaders in secondary school science teaching. They immediately associated these problems with those posed by a decreasing percentage enrollment in high school physics and advanced mathematics courses, the small number of college students preparing for careers as science teachers, and the loss of active high school science teachers to military service or to more remunerative positions in industry. Here was ample motivation for planning a carefully organized effort to increase the numbers and quality of high school science students and science teachers.

How Was the Foundation Planned?

The National Science Teachers Association has had for many years an active Committee on Professional Relations and Projects. This Committee, using its earlier experiences and proposals developed preliminary plans for a program geared to this situation. The Board of Directors favored the plan in principle and authorized a protem committee for further planning. In February of 1952 the Board approved the broad outlines of a plan, which in March was placed before representatives of 19 major national organizations concerned with scientific and engineering manpower problems. A series of meetings were held, and the proposals and plans were progressively revised and clarified. Twenty industrial companies made modest grants to cover expenses incident to the developmental work. Finally in July of 1952 the Board approved the plans and appointed an administrative committee to carry forward the development of the new organization. This committee still further refined the plans and proposals until January, 1953, when stage I of the Foundation's plan was actually launched. I shall come back to this a little later.

The names of the Administrative Committee may be of interest to this audience. They are, in addition to myself:

Dr. Allen V. Astin, Director of the National Bureau of Standards
Mr. Hugh E. Brown, Educational Chart Editor, W. M. Welch Manufacturing Company
Mr. Robert H. Carleton, Executive Secretary, National Science Teachers Association

Dr. Charlotte L. Grant, Dean of the Junior Class and Instructor in Biological Sciences, Oak Park and River Forest High School, Oak Park, Illinois, and President Elect of the National Science Teachers Association

Dr. Philip G. Johnson (Chairman of the Administrative Committee), Specialist for Science, U. S. Office of Education

Dr. Milton O. Lee, Secretary-Treasurer, Federation of American Societies for Experimental Biology

Professor Ralph W. Lefler, Assistant Professor of Physics and Education, Purdue University

Dr. Harold E. Wise, Assistant Dean of the Graduate College and Professor of Education, University of Nebraska, and President of the National Science Teachers Association

This Administrative Committee will be seen to be broadly representative of the physical sciences, engineering, biological sciences, high school and college teaching, and science teacher education. Further representation for scientists, engineers, and industrial leaders is provided through a board of consultants composed of persons designated by sponsoring and advisory groups. This board is now being developed and already includes official representatives of ASEE, of the Engineering Manpower Commission, and several other groups.

This brief history of the origin and development of the Future Scientists of America Foundation has been given in some detail to emphasize the fact that people representing all the major agencies concerned with the general manpower problem have been consulted time and time again, and their ideas thoroughly considered in the planning and development of the Foundation. This undoubtedly explains why the Foundation has been able to win the wide endorsement which promises the financial support and generous advice necessary for a really constructive action program.

What Is the Plan?

The Foundation recognizes six elements in the over-all situation, some of them problems, some of them means toward a solution. These are (1) an expanding economy based on progress and preparedness, (2) shortages of scientists, engineers, and technicians, (3) a serious decrease in the number of well-qualified high school science and mathematics teachers, (4) falling enrollments in senior high school physical sciences and mathematics, (5) expanding science enrollments in grades 7, 8, 9, and 10, and (6) a developing elementary school science program. Involved in the over-all situation to a greater or less extent are about 25,000 high schools, 65,000 science teachers, and 4 million science students.

Considerable study was given to the proper name for the organization which seemed called for under the general conditions prevailing. The name finally chosen was the Future Scientists of America Foundation. Each word in this title was carefully considered, and legal counsel was available before the final decision was made. It was decided that responsibility for the organization had to reside somewhere, and that there were many reasons for making it an activity of the National Science Teachers Association. One reason was that as an official department of the National Education Association, chartered by the Congress as a scientific and educational organization, it has exemption under Section 101(6) of the Internal Revenue Code. Incorporation of the parent association also applies to the Department; therefore, no separate acts of incorporation were necessary. The fact that the Association is an affiliate of the American Association for the Advancement of Science was also believed to be of considerable value.

The purposes of the Foundation are basically two, namely to help *all* high school youth understand the basic principles of science, engineering, and technology; and to help *able* high school youth to become interested in and to prepare

for careers in these fields and in science teaching.

The fields of action for the Foundation were selected after careful study, and even now they still represent *proposed* fields of action. They are (1) coordinating and strengthening curricular information and guidance services for high school students, (2) developing and extending science achievement awards for high school students, (3) expanding and improving specialized training opportunities for high school science teachers, (4) encouraging and managing awards to outstanding high school science teachers, and (5) promoting research on problems of high school science teaching. It was and still is the judgment of the leaders in science teaching that these are worthy of serious consideration, but they also wish possibilities to remain open for further suggestions.

The *methods* are also proposed. They are (1) cooperation in providing a source for helpful information; and (2) operation when after careful study it seems desirable to supplement what is already in existence.

The first need of the Foundation is for an executive staff to help advance the plans. The second need is for funds to provide for the operation of projects and for the expenses of consultants and committee members who guide the projects. We have no immediate need for funds for office space and furnishings, which are being provided by the National Education Association. We ask for no funds for the Administrative Committee, the members of which are glad to donate their services to the Foundation as long as actual expenses are underwritten.

How Is the Plan Related to Existing Services?

The basic purpose of the Foundation is to secure for junior and senior high school science students and their science teachers services which will be comprehensive counterparts to the existing and planned services directed primarily at college and postgraduate levels. With this in mind, two-way relationships have been established with the Engineering Manpower Commission, the Scientific Manpower Commission, the Manufacturing Chemists Association, the National Science Foundation, and the American Society for Engineering Education, and will be extended to other organizations interested in the over-all purposes of the Foundation. It is our purpose not to attempt to replace any agencies now working in the general field of the promotion of science and engineering, but rather to supplement and coordinate their efforts so that there may be a continuous endeavor extending from the elementary school through the secondary school and the college up to and including postgraduate levels.

What Activities Are Now Under Way?

The Foundation has been in actual operation for several months. We are now concluding the second year of an Awards Program for junior and senior high school students and science teachers sponsored by the American Society for Medals, and we are laying plans for the third year, for which funds have already been assured by the Society.

A report of this activity for the current school year shows that 50,000 posters announcing the program were distributed through junior and senior high schools in the early fall. Replies from about 1300 of these schools have asked for 18,551 student entry forms and 2500 teacher entry forms. Student entries numbering 847, but representing over 1000 students because of group projects, and 46 teacher entries are now being studied, and the actual awards will be made early next fall during American Education Week. There will be 104 monetary awards to students, 20 monetary awards to teachers, and certificates to individuals, medals to winners, and plaques to schools.

What Acitivity Is Soon to Be Launched?

A meeting with about 15 potential industrial sponsors was held in December

1952. This led to a brochure and an invitation to provide funds to underwrite a budget of $35,000 for stage I of the Foundation's program. The invitation for support has so far been extended to about 40 sponsors and contributions have been received from 11 of these, totalling $10,150. A secretary has been employed to assist in launching the project and to carry forward plans for extending the number of invitations.

Stage I involves the development of an inventory of incentive programs, career information, and services and specialized training opportunities now available or planned for high school science students and teachers. An inquiry form to secure information pertinent to the project has been developed through the assistance of a group of persons who met in Washington in April. This has been mailed to a selected list of teachers and schools. Another form to societies, industries, and other agencies has also been developed, based on suggestions of the same group of persons, and has been mailed to a few organizations for pretesting. Information received through the use of these two inquiry forms will be supplemented in developing the inventory list. We expect to have a full-time project director on the job in August for a period of at least six months. He will, with the aid and advice of the administrative committee and the representatives on the Board of Consultants, make a thorough study of this material and a re-appraisal of the problems and the means and methods for solution. Plans for future activities of the Foundation will then be based on a reasonably accurate and complete knowledge of current and planned activities and services.

What Will Follow as the Foundation Develops?

The five major project areas which I have mentioned will be restudied in the light of the findings of the inventory. We are making no firm commitments at the present time as to future activities of the Foundation. It is certain that if the current general impressions about the manpower situation and the available services are substantiated, there will be continuing activities of the Foundation. It is my personal judgment that the study will reveal a need and a desire for certain types of continuing services for high school science students and their teachers. However, we are holding these ideas as opinions for the present, awaiting the results of the study, which we believe is the way we ourselves can follow scientific methods and attitudes as we face the problems of improving science instruction.

Summary

The Future Scientists of America Foundation is based on the assumption that the best way to improve the long-range supply of engineers, scientists, and technicians is to increase the numbers of qualified boys and girls coming out of our high schools with adequate preparation for good college or technical institute work in these fields. We hope to do this through guidance services to students and teachers, through award programs, and through other activities. The plan has been developed through wide consultation with many interested individuals and organizations. The Foundation is an activity of the National Science Teachers Association, operating under an Administrative Committee with the counsel of a Board of Consultants. Five important areas of activity have been proposed, but thus far only one, an Awards Program, is in operation. Even here four additional programs are envisioned. The second activity, which is now starting, involves the development of an inventory of incentive, guidance, and specialized training opportunities for high school science students and their teachers. We are making satisfactory progress, although still incomplete, with the underwriting of the budget to maintain the Foundation and we are developing two-way relationships with several major groups concerned with high school

science teaching. We believe that the progress thus far made gives promise of further developments which will merit the respect and support of high school science teachers and administrators, as well as of leaders in industry, research laboratories, foundations, educational institutions, and other agencies. The suggestions and criticisms of members of the American Society of Engineering Education are invited, and your help in the projects will play a large part in determining how effective the Future Scientists of America Foundation will actually prove to be.

Accreditation of Engineering Curricula

A one-year trial cooperative program between regional and professional associations which evaluate colleges and universities has greatly improved accrediting procedures, according to Ewald B. Nyquist, secretary of the Middle States Association. He based his findings on a program between the MSA and the Engineers' Council for Pressional Development.

The MSA's Commission on Institutions of Higher Education is collaborating with ECPD and 25 other professional accrediting agencies. Mr. Nyquist spoke at an accrediting panel in a joint session of the American Society for Engineering Education and the ECPD at the Hotel Statler, New York City. Four hundred engineering, educational, and industrial leaders attended the four-day meeting of the two organizations.

Describing the program of the MSA and the National Commission on Accrediting, Mr. Nyquist reported progress in reducing abuses in accrediting. Among these evils, he listed the duplication of functions, excess number of accrediting bodies, destruction of institutional rights and power, excessive costs, superficial quantitative standards, and detrimental enforcement policies.

Principles in the Commission's activity, Mr. Nyquist said, include the following:

1. That improvement of higher education is best achieved when based upon self-evaluation prior to examination by outside specialists.
2. That an acceptable program of accreditation should be fostered on a nation-wide basis, and
3. That accreditation should exist primarily as a stimulus to institutional growth and development rather than merely a standardization based upon minimum criteria.

In evaluating institutions with engineering units, the MSA draws on the ECPD for expert personnel. ECPD reports are included in total evaluation reports. Cooperation also extends to questionnaires, schedules, exchange of confidential information, and costs billing.

The cooperative evaluation program, Mr. Nyquist said, should result in more effective development of engineering schools and curriculum. Further, he stated, "ECPD will be provided with an additional opportunity for interpretation of engineering education to educators in other fields and to other departments of a complex institution."

How Can We Instill in Our Engineering Students a Desire for Continuing Self-Improvement?*

By JOHN W. SHUPE

Assistant Professor of Applied Mechanics, Kansas State College

Upon the completion of a four-year college program, the normal engineering student will find that only half of his course work has been taken in the School of Engineering. Suppose that it were possible in those two short years to have exposed this student to all of the technical knowledge available in the field of his specialization, in addition to his basic engineering work. Assume further, that he was capable of retaining this vast quantity of information. Still in a comparatively short time, this student will discover that it is essential for him to continue his studies if he wishes to remain informed on the current advances of his profession.

To consider the subject from a somewhat more practical viewpoint, two years of training is insufficient to develop a professional engineer. The most that can be expected from college training is the essentials of a fundamental education; and continuing growth in knowledge, judgment, and technical skill is necessary to approach and maintain professional status.

In either case, it becomes apparent that a student's training must not be terminated by the conferring of a degree. There is no once-and-for-all education for an engineer. Therefore, it should be the primary aim of our instruction to develop in the student not only the ability, but, equally important, the desire to continue independently in his search for additional knowledge, and for the solutions to unfamiliar problems.

In analyzing our present methods of instruction, it might be well to review the general trend of engineering education. Before World War I the type of training which an engineering student received was for the most part designed to equip him for empirical engineering practice. There was very little theory presented, and the college graduate was an accomplished "hand-book" engineer.

A little later, the possibilities of theoretical analysis were recognized and incorporated into the engineer's college training. Shortly afterwards it was realized that an engineer must be qualified to handle people, so a place was found in the majority of curriculums for some humanistic courses. Finally, it was generally agreed that an enigneer must have a well-rounded personality and a broad outlook, so provision was made to include some form of general education.

Technical Advances

While this trend has been taking place, new technical advances have occurred, and new methods and procedures developed which have also been included in this four-year training period. As a result, in the endeavor to teach more theory, more methods, more technical data, more general education, and more human relations our present educational system leaves little time in which to encourage the develop-

* Awarded Honorable Mention in Young Engineering Teacher's Paper Contest, sponsored by ASEE.

ment of two of the most important attributes of an engineering mind—a natural curiosity, and the ability to reason. Without these two qualities, a graduate engineer will have difficulty in maturing in a professional sense.

From a positive standpoint, there is very little that can be done to develop natural curiosity. However, this natural curiosity can be greatly retarded or suppressed if a person, whether due to a lack of fundamental knowledge or the ability to apply this knowledge, continually fails to arrive at a satisfactory solution to the problems which his curiosity initiates. In order to keep actively curious, the mind must produce results based upon facts and the ability to reason. Assuming that the normal engineering graduate receives an adequate amount of knowledge in his college work, and judging from industry's overall appraisal this seems to be the case, then the challenge to our teaching methods is presented by this other requisite—the ability to reason.

An instructor should indicate to his students that he is attempting to develop their reasoning ability; it should be listed as one of the objectives of the course. As soon as the class commences to use its new-found material in solving unfamiliar problems, the instructor should emphasize the reasoning involved in the solutions and point out to the students the manner in which they are exercising their reasoning ability. The student must first develop self-confidence in his reasoning, if he is expected to expand in this direction.

Some students will argue, "I'm not so good at original thinking"; and they are no doubt telling the truth. But the application of known principles to a slightly different situation certainly does not come under the category of "original thinking." Certain facts, principles, and laws must be memorized in mastering subject matter. However, there is a tremendous gap between this learning by rote and true original thinking. It isn't at all limiting to say that the aim of instruction should be somewhere between these two extremes.

An instructor should not be overly ambitious in the amount of course work that he covers. Many engineering texts contain more material than can possibly be discussed in the time allotted for the subject. Each course should have a definite amount of fundamental material which represents the minimum that should be taught to the student. Beyond that point careful consideration should be given as to whether the time can be spent more profitably in teaching more methods, more short cuts, and more specialized data or in going deeper into the subject and attempting to develop thinking power along those lines.

Questioning Technique

The questioning technique in the majority of our engineering texts is not intended to encourage a great deal of reasoning. As a rule, the questions are listed at the end of each chapter, occasionally even subdivided as to section, so that a student in solving a problem looks up the example which seems to apply and follows through the method of solution. This is probably an exaggeration, but for the most part the standard textbook problems seem unsuited to the development of this reasoning ability. Unless there has been an error in publication, a problem is seldom printed which contains unnecessary or insufficient information. The problems are concisely stated using standard symbols, and with facts clearly stated. The majority of problems definitely should be presented in this manner, but the instructor should occasionally supplement this type of problem with one which involves some constructive thinking. In actual practice, the graduate will not find the facts listed in a, b, c order, with the method of solution suggested.

In analyzing an unfamiliar problem there are certain properties that a student should look for. The first thing to be determined is "What is the question?" This is necessary, since the pertinent data are frequently so cluttered up with superfluous material that the meaning of the

problem is doubtful. After the student has sifted through this unnecessary wordage and arrived at the meat of the problem, he should next ask himself if a solution is possible. Unfortunately, every problem does not have an answer, and a great deal of effort can be wasted in attempting a solution based on insufficient data.

In determining if a problem has a solution, the number of unknowns present, and the number of independent equations available should be considered. If the unknowns exceed the number of independent equations, an exact solution is unlikely, but the problem still may be worthwhile, from the engineering viewpoint, by either of two approaches: It may be possible on the basis of the data to set up definite limits between which the answer must fall, or by making an assumption, the problem may be solved for an approximate solution. A great deal of engineering work is done in this manner, and an early exposure to this method of procedure is worthwhile for the engineering student.

The student should learn to differentiate between facts, assumptions, and conventions. If he is working exclusively with facts that completely satisfy the conditions of the formula, then he is justified in working out the solution to a great degree of accuracy. Assumptions should be approached more carefully, however. They may be reasonably close or only a rough approximation, and the validity of the answer should be consistent with the quality of the governing data. The student should realize that he is introducing false accuracy into an answer, if he expresses the solution to four significant figures when one of the controlling variables was approximated to the closest ten per cent.

Similarly, in teaching sign conventions, such as a clockwise moment being positive, the instructor should emphasize to a student that conventions are not hard and fast rules, but are merely set up as a convenience to aid in the solution of problems. A student should develop respect for the facts, skepticism for the assumptions, and willingness to completely reverse the conventions if it suits his purpose.

Classroom Discussion

Every effort should be made to encourage classroom discussion, not only on the material of the instructor's choice, but on questions and problems originating from the students. A class will be more interested in problems of their own selection, and this will also give the instructor the opportunity to illustrate the thought processes he goes through in approaching an unfamiliar situation. Rather than attempting to impress the class with the ease and rapidity with which he can arrive at a solution, it will be more beneficial if the instructor takes time to orally evaluate the problem, to point out the reasons why he mentally rejects some possible solutions, and to explain why his chosen plan of attack seems the most reasonable. He may be called upon to defend this stand, if a student feels as though another method of solution is superior. This is a healthy condition, since any variance of opinion involves a certain amount of independent thinking on the part of the members involved.

It is possible to misplace the emphasis in attempting to develop a student's reasoning ability. If an instructor tells his class, "In order to reason through a problem of this nature, follow these four steps . . .," and proceeds to outline the steps, then all that he is teaching is another method, since there is no independent thinking required on the student's part. An instructor should not endeavor to have a class duplicate his thought processes, but have them develop analytical ability of their own.

Teaching by Example

An instructor should continually keep in mind that a great deal of the information and the attitudes that a class derives from his course are based as much on his example as on what is said. Recently, one of our professors, on entering emeri-

tus status, received a congratulatory letter from a former student who is now a successful engineer. In reviewing his college training, this former student related that one of the most worthwhile features of his college work had been the fine sense of ethics he had acquired in attending one of the professor's classes. "Ethics," snorted the professor, "I never even mentioned the word," and he probably hadn't.

There are other phases of instruction that are taught by example. The best method of increasing the technical vocabulary of a class is not to have them memorize a list of words, but to use the technical terms frequently in classroom discussion. Similarly, along the lines of general education, an instructor with a broad view of his work and a general appreciation of the world in which he lives, can have as great a liberalizing influence on the engineering student as some required course designed for this purpose. Therefore, in developing the reasoning ability of a class, the instructor, in his discussion and explanation of difficult material, should give some evidence of using the analytical approach, and build up the student's confidence in its possibilities.

The probable origin of the word "engineer" is the medieval Latin word "ingeniarius" which also fostered the words, engine and ingenuity. In training engineers, the instructor should concentrate on making the students more ingenious and less like engines, which are machines that go through repetitive motions. He should encourage in every way possible the development of a curiosity and a desire for self-improvement, so that the student will continue to grow, professionally and socially, upon graduation. The instructor should emphasize the analytical approach, for this approach is not unique with our engineering experiences. Judgment, based on a careful consideration of the facts involved, should govern the decisions in all phases of human endeavor.

College-Industry Conference

of the

Relations With Industry Division

will be held on

January 16, 1954 **University of Detroit**

Helping the Student Master the Art of Thinking*

By KIN NEE TONG

Assistant Professor of Mechanical Engineering, Syracuse University

After meeting a new class in recitation for a few times, an instructor in engineering sciences can usually sense which pupils in the class are going to do well in the subject and which ones are likely to fail. Although he is not willing to be opinionated by such first impressions, he cannot help feeling secretly that there is some intangible quality in the individuals of the class that separates them into different scholastic strata. This is indeed a most frustrating feeling. To accept the existence of such stratification is to admit the limitation in his possible accomplishment as a teacher. His role would then be restricted to the giving of information; his performance could be reflected only in the general level of class progress; and his work would benefit the individuals only according to their latent capabilities, and thereby help to perpetuate and intensify the process of stratification.

There is no sense in arguing that all individuals are mentally equal; nor in advocating that a class be escorted like a convoy, moving with the slowest ship. Nevertheless, it is doubtful that all the differences in the performance of individual students can be attributed to the differences in basic intelligence, in mental aptitude, or in whatever names are used by the numerous tests given to entering freshmen. Leaving personality problems to the psychological service, personal problems to the dean of men, and other academic problems to the private tutors, an instructor shall still find means whereby he can bring up the rear rank without slowing down the pace of the forerunners. A group of untutored beginners in golf will card vastly different scores on their first games. The club pro can usually narrow down the difference by a few group lessons. He can never make everyone play equally well or all play under par; but within certain limits, he can teach all of them to play decent games. Why, then could not a college instructor achieve similar results?

Great ideas require genius; important invention calls for creativeness; but good engineering needs only some fundamental knowledge and some original thinking. An undergraduate program in engineering contains very little subject matter beyond the comprehension of any qualified freshman. Its object is within the mental reach of virtually all. Engineering schools do not aim to turn out Edisons or Teslas or even the kind of men who could invent the zipper. Their aim is far more modest —something of the order of better mouse trap builders. The necessary genius and creativeness needed for building better mouse traps are, after all, more common. If granted that fundamental knowledge and original thinking are the mainspring of good engineering, one may proceed to examine their nature. All quarters more or less agree on the make-up of the basic knowledge required in various fields of engineering; and students in education and psychology have theories on how this knowledge can be best imparted. But opinion varies when it comes to the ques-

*Winner of Honorable Mention in the Young Engineering Teachers' Paper Contest sponsored by ASEE.

tion of what is the nature of the original thinking essential in the engineering profession.

Logic and Order

One often hears the extolling of so-called logical and well ordered thinking. To be sure, logic is the main binding force in the structure of all science; and orderliness is the essence of all engineering feats; but it must be realized that nice logic and neat order are usually only the end-product of a thinking process which in itself may be neither logical nor orderly. How many neat solutions and elegant proofs were first thought of in the way they are presented in the textbooks or by the instructors in class? In most of them many missteps were made before the final results were obtained in the so-called presentable forms. An instructor may use up pages to prepare his lecture on the solution of a certain problem, only to find afterwards that it can be solved in a more direct but unforseeable way. Steeped in the tradition of Euclid and dazzled by the beauty of Aristotelian logic, he presents to the class the finished product of his thought in a most impeccable manner. Repeated exposure to such exhibition of mental feat gradually leads the students to believe that this is the way a problem should be and usually is attacked: logical, well ordered, and straight to the answer. If they fail to do the same with a new problem, they cannot help feeling that they are either too dull, or do not know the subject well. Most give up before they are half through. A few exceptionally bright ones may actually develop uncanny ability by studying uncanny ways, and thus serve to intensify the general frustration of the rest.

In the evolution of physical sciences, it is now recognized that there exists an incongruent duality in the making of science and the make-up of science. The neat and orderly "Rules of Philosophy" formulated by Newton in his Principia have long given way to the opinion of Einstein—"There is no logical way to the discovery of elemental laws." The pursuit of science is more an art than a science and, as H. D. Smyth said, "The research man may often think and work like an artist, but he has to talk like a bookkeeper, in terms of facts, figures, and logical sequence of thought."

While a pure scientist, owing to his relationship with his fellow workers and with posterity, has to distill his triumphant insight into hard facts, cold figures and bare formulas, a teacher in applied science has a more personal relationship with his students than a mere walking textbook. Neat derivations, and concise solutions serve only to prove the results are right; they do not give any idea of how an average person may arrive at the right results. A teacher in sculpture does not merely show his finished work with most of the chisel marks removed. He is expected also to show how he used his chisel.

Process of Reasoning

Attacking an engineering problem involves aspects as artful as sculpture. It is an important duty of an instructor to reveal to his class his private process of reasoning. Owing to his experience in solving problems, his reasoning is perhaps more straightforward than what his students are capable of, but it is still a far cry from what appears customary on classroom blackboards. Admittedly, it is not wise for an instructor to flounder around in front of a class. Consideration of his dignity aside, it is a waste of time and a waste of students' attention. Nevertheless, rational steps, which a person without the benefit of clairvoyance are expected to take, should not be summarily omitted, just because they prove to be unnecessary afterwards.

This common habit of demonstrating only the most direct and economical approach is perhaps formed unintentionally. Lectures prepared down to every detail, experiments with all the kinks ironed out beforehand, and standard problems used year in and year out, all contribute to ob-

secure the side issues which are likely to trouble any one who encounters them for the first time. Perhaps lectures should be prepared only in outlines; experiments should be prearranged only to avoid dangers and damages; and problems should be worked out impromptu in class. For those who know the subject too well, for those whose stubborn conscience compels them to be ever-prepared, the kinks and twists in normal thinking process can always be premeditated; and for those having the false pride of always showing their best, teaching a new and more difficult course may be in order.

Of course, there is also a consideration of time involved. It is difficult enough to cover a course in the usual manner without much digression, but if one is convinced of the value in demonstrating the art of thinking as well as the fruit of thinking, one should, and can somehow find time to do so occasionally. In any event, it should be emphatically pointed out to the students that there are two facades in any piece of original work, a private one and a public one. The private one is a silent but important partner in any mental undertaking.

Nowadays analysis is the magic word, and logic is the sacred cow. Both are undeniably essential in original thinking, but by their very nature neither of them can originate ideas. One can analyze things only when things are there, and one can reason by logic only when there is something to reason from. Even in mathematics, where the analysis and logic are most powerful, solutions of problems and proofs of theroems often require as much artful maneuvering in algebra, as pure deductive logic. Take the following remarks from an excellent textbook on differential equations by R. P. Agnew: "It is often possible to solve complicated differential equations by making a sucession of changes of variables. A standard procedure is to *try* various and assorted changes of variable, making use only of those which appear to simplify the equation, but if the equation occurs in an important problem, one can spend odd hours, days, weeks, or years hunting for them. We shall not illustrate the process of trying assorted changes of variables which fail to simplify the equation, but we shall illustrate results obtained after finding useful changes of variable." Such remarks, so obvious to an experienced mathematician, can be really shocking to many students, who never suspected that: (1) Not all differential equations are solvable; (2) Simplifying changes of variable, if any, are obtained by trials; and (3) There are problems important enough for people to keep trying to solve them for years. Can such naïvety be blamed when all problems ever presented to them were solved by a single assortment of changes of variable found within one class period?

Intuitive Experimentation

Most problems in engineering are not as well formulated as ones in pure mathematics. An exact solution either does not exist or is not unique. The possibility of making different judicial assumptions, gives added leeway and added necessity of experimentation in the avenues of attack. There, analysis is a weapon, logic is the rule of operation, but intuitive experimentation is the source of ideas. Students are so often admonished when they try to guess at an answer, that they consider guessing a sin. Guessing is not sinful so long as logic is always there to call "foul" when a foul is actually committed.

The ability and resourcefulness in tinkering with problems accentuate the qualities of good students, and depreciate those of the poor. In many cases, proficiency of good students in this artful aspect of thinking is fostered by their activities outside of classrooms, such as solving puzzles, playing chess and hobbies in crafts. Custom is such that except in advanced design courses, most of the problems illustrated or assigned are chosen for their direct bearing on the principles being studied. They are good drills for learning the laws and the relationships of physical phenomena. However when examination comes, most instructors are tempted to

insert a trickly problem to separate the men from the boys, so to speak. The result is the common complaint of poor students that they have worked every problem in the book and yet failed the examinations. Tricky problems can of course be avoided in examinations as well as in daily work just to quiet the complainers, but why postpone the facts of life until it is too late to do anything? It seems to be more sensible to make trick problems part of the regular diet, not for the sake of their nutritious value but for the sake of drilling the digestive power. The policy of mass high school education in this country does not permit room for intensive mental drills found in its European counterpart. Room, however, should be allowed as soon as professional education begins, without resorting exclusively to problems typified by Cambridge tripos.

The Art of Thinking

Any attempt in improving students' art of thinking, would give the slower minds more of a chance, without hampering the brilliant ones. Being an art, it cannot be taught by any set of stereotyped rules. The peculiarities in the functioning of the instructor's own private mind, dictate the best method for him. Perhaps all that is needed is just to be himself and to show how he does this or would do that. At any rate, no one can learn entirely by observing the mistakes made by others. Students must be urged and encouraged to drill their own minds, to make their own mistakes, and to correct their own mistakes. Judging and appraising the student's performance only by the end product are not conducive to the development of a sound and diligent thinking habit. Effort should be a criterion in grading any piece of work. Students who failed to get an answer after some reasonable trial, deserve far more credit than those who could not take a single step. Only in this way can one induce them to think, hoping in the long run they will master the art of thinking through constant practice.

It is perhaps appropriate to conclude this paper by a historical note in education. The ancient method of teaching children to read in China was to force them to memorize verbatim great classical works written in a language having little resemblance to the spoken language of the day. The teacher never explained what the words meant. The theory was that some day after five, ten, or twenty years of this, revelation would come to the students and everything they had memorized would make sense. The theory worked in some cases, and great scholars were produced that way. To many others, however, revelation failed to come, and they lived to be well versed illiterates. There may be some faint parallelism between this extreme method of teaching and some aspects of the common modern practice.

Young Engineering Teachers' Paper Contest

RULES

Eligibility: Members of ASEE who are not over 35 years of age (their 36th birthday must not be before June 1, 1954).

Awards: First prize $200—Second prize $100.
Honorable mentions as determined by the Judging Committee.

Presentation of Awards: The awards are known as the "President's Awards." They will be presented to the recipients by the President of the Society at the Annual Banquet at the University of Illinois, June 17, 1954.

Subject: Papers should deal with some constructive phase of improvement of engineering education. Participants are encouraged to use their own judgment in selecting appropriate subject matter.
The following are suggestions of possible subjects:

1. Professional development of the Young Engineering Teacher.
2. How should the student be helped to learn to deal with situations that are new to him, on his own initiative and with well-ordered professional thinking?
3. To what extent should modern physics be included in the engineering curriculum and how should this be done?
4. What areas of physics, chemistry, mathematics and biology not now taught in engineering curricula are likely to be translated into significant engineering practice in the next 25 years and how should this influence present curricula?
5. To what extent and in what manner should undergraduate instruction acquaint the engineering student with the methods of research and with recent research developments in engineering and closely allied sciences.
6. What should be taught of the art of engineering as contrasted with its science?
7. What basic science, mathematics and communication principles and skills can best be taught by separate department staffs and what part by integration into engineering courses?
8. What can be done in college to prepare the young engineer to continue to learn after his formal education is ended?
9. How should non-major courses in engineering such as electrical engineering for non-electricals be planned as to content and method?

Length of Paper: Not to exceed 2500 words.

Submission of Entries: All entries should be submitted to the Chairman of the ASEE Section in which the member resides before March 1, 1954. Names and school affiliations of Section Chairmen are published each month on the page in the Journal of Engineering Education designated "Section Meetings." Papers submitted in the contest last year or in other contests are not eligible for this year's contest.

Judging: Each Section of ASEE will appoint a Judging Committee to select the best paper from the Section. This paper will be submitted to the ASEE Secretary before April 1, 1954.

The winning papers from the various ASEE Sections will be submitted to a Final Judging Committee for the final selection.
Here is an opportunity to gain national distinction. Good luck!

Engineering Education from Industry's Viewpoint—One Man's Impressions

By RICHARD H. LEACH

Assistant Professor of Social Sciences, Georgia Institute of Technology

I enjoyed a unique experience during the summer of 1952. As a Fellow of the Foundation for Economic Education, I spent six weeks with the management of one of the nation's largest industrial firms, where, among other things, I had a chance to look over the academic fence from the other side. What I learned from my vantage point I want to set down for the benefit of my colleagues in engineering education before it loses its urgency.

General Impressions

The strongest impression I carried away, while it may not be new, was at least heartening to feel again. That is how important graduates of engineering schools have become to the management of industry—and thus how important their education is to industry's successful operation. They run American business, by and large. The company men I talked to agreed that there will always be a certain number of management people who work up from the ranks of workers, without the benefits of formal education, and this is as it should be. They agreed too that there will be others who come to industrial leadership from the liberal arts, and I think no one will belittle the contributions of such men. But they all emphasized that engineers remain chiefly responsible for a healthy industrial system. Eight out of ten men hired for management jobs in my host company are the products of engineering schools, and this is a common ratio. Moreover, company recruiting is more often than not begun on engineering campuses—industry, in other words, comes to us first to fill its needs. It was a great boost to my morale to realize again that I as an engineering educator am in the center of things, that I help to build the builders, that neither I nor my students have a mean or uninspiring role to play in life.

Secondly, I was impressed by the sympathy with and interest in engineering education the average industry man demonstrates. It was immediately obvious in every conversation that industry men gratefully acknowledge the vital role technical schools play in the success of their enterprises and that they are more than willing to do whatever they can to help us accomplish our educational job better. There were five professors in my group last summer, and each company official we met went out of his way to meet our individual needs. Their very attitude made me all the more anxious to reciprocate in turn and to offer them the very best graduates I can possibly help train.

My third impression, to which I want to devote the rest of my remarks, was that, despite praise and sympathy therefor, engineering education is not in every respect all industry people would like it to be. I recorded a number of their suggestions for improvement and change, and all, I think, are worthy of serious consideration.

Need to Develop Coordinated Curricula

One often repeated suggestion was that engineering educators should strive to develop better coordination with industry in planning curricula, in order that course

offerings may be better kept in tune with industrial needs and problems. Let me give two cases in point. In the company I visited, there is a real need for metallurgists. Yet few engineering or technical schools stress the subject or are equipped to offer it. Here is a real industrial problem which we to date have not met in our curricula. On the other hand, schools all across the land have vied with each other in setting up courses in industrial management, until the possible turnout of industrial management majors far exceeds the number of junior management jobs open to graduates. In such an endeavor, we are wasting both our efforts and considerable student-power which might better be utilized elsewhere.

One solution suggested to such curricular mismanagement was the establishment of industrial advisory committees to help correlate industrial needs and school offerings. Another was that engineering schools be made parties to the findings of the periodic surveys most companies make of their manpower needs, so that curricula could be tailored to fit the actual projected industrial picture. It seems to me there is merit in both ideas.

Weakness of Educational Guidance

Another common sentiment in industry, with which I heartily agree, is that engineering schools do not excel in the guidance of students toward the most suitable course offerings. Not only are we careless in establishing the proper connections between college guidance officials and placement officers, but many of us who guide are not up-to-date in our knowledge either of the school's total course picture or of the industrial pattern in the world outside. We ought not let students flounder along to a major. We should guide them intelligently toward one that both fits their capabilities and propensities and offers them a relatively certain chance of finding professional usefulness. Nor should we continually guide toward management—basic industrial jobs are important too. We probably over-emphasize management, in fact, to the possible detriment of our curricular strength.

Perhaps because engineering schools have not made a brilliant record at guidance, or perhaps only to supplement their activities, many industrial concerns now do their own guiding. I heartily recommend such efforts. But the real guidance job remains the faculty's; we cannot evade responsibility for it. It appears from what I heard last summer that a serious evaluation of that job is in order on many of our campuses. It is a suggestion we might do well to honor.

Need for Contact between Teachers and Industry

Many company officials felt that another thing needed was more opportunity for contact between those who teach engineers and those who hire and use them. I agree with them that to be effective teachers, we need to know industry at first hand, to see its methods and techniques in operation. We need frequent immersion in an actual industrial environment. But at present few of us have opportunity to do so. Fortunately, the opportunities are increasing. The Foundation for Economic Education, under whose College-Business Exchange Program I was a Fellow last summer, has made it possible to date for 288 professors from 162 colleges to spend six fruitful weeks with 96 of America's leading business concerns, and more such school-factory interchanges are scheduled for this summer. Many individual companies have adopted the idea of inviting professors for short periods. For instance, United States Steel's Columbia-Geneva Division last year held a nine-day educational session for a limited number of college people on the West Coast. And attacks are being made on the problem by other organizations and by several schools themselves.

More needs to be done, however, for the number of educators reached so far is only a tiny proportion of those who man our technical institutions. And we should

work to make the thing a two-way street. The colleges should increasingly open their doors to men from industry, if not as teachers, as occasional lecturers; if not as lecturers, as visitors and advisers, so that technical education can become much more of a partnership between the parties concerned than it is at present. These are educational developments whose possibilities are only now being realized. They are, moreover, developments of which industry heartily approves, and we should not hesitate to make the most of them.

Need for Economics

I often had this question asked me as I moved from department to department in my host company: "Why don't engineering schools teach their students the elementary facts of economics?" It was usually followed by the charge that engineers are turned out by the hundreds without the faintest idea of the principles that make our economic system tick and without any background in business as a whole into which to fit their job and their company. More than on any other point, the industry people I talked to agreed that there is a general and great need for economic education in the men who come to industry from our campuses. And it is true that too few of our graduates have any grasp at all of practical economics, of how business operates, of the economic process from raw material to finished product. Too few have any idea of the whole industrial circle, what and who it involves, how great a variety of jobs and functions it entails. Nor are they sure what relationship they as engineers bear to the rest of the industrial family. This flaw in their education affects their understanding of the business they enter and of its relation to the rest of the nation and the world.

It is our job as educators to awaken to the situation and see to it that the engineering curriculum is made broad enough to include a course or courses in basic economics, required of all our students, if we would properly fulfill our obligation to them and to their employers, as well as to society as a whole.

Over-specialization

Closely related to the need for training in economics is the general problem of what the total amount of non-technical courses ought to be in the engineering curriculum. One of the most challenging ideas I encountered was presented by the director of industrial relations for one of the largest manufacturing companies in the United States, when he discussed the subject of over-specialization in engineering education. He admitted that his company, like others, wanted and hired men with technical specialties, but he deplored the fact that so many came to them with nothing else. His point was not that engineering schools need turn out anything but engineers, but that in turning out engineers, they ought to take pains to produce graduates with knowledge and understanding in fields other than engineering. He said that his company often felt that some of their neophyte employees might as well have come from trade schools as from accredited engineering schools, so deficient in any knowledge beyond their technical specialty were they. He did not for a minute deny that we produce fine engineers, specialists in things. But he felt that we send those specialists out into the business world completely unequipped in other, equally important, areas of knowledge. Companies want men who are more than one-sided, who have besides professional competence at least a knowledge and an understanding of the social aspects of life—the human factor, if you will. He expressed the firm conviction as he concluded that for present day business leadership, broader education of some sort was a necessary qualification, and he urged us to train our students more intensively along non-technical lines.

Representatives from five other industrial firms in the Pittsburgh area heard him make these remarks, and all of them hurrahed when he made his points. They

were unanimous in their opinion that so far engineering education is weak on the human side, a weakness that has become chronic through the years, a weakness all of us need to study seriously and seek to correct. So widespread has the feeling become that recruiting people from two or three of the firms in the Pittsburgh area have begun to hire fewer engineers and are turning instead to business administration or liberal arts graduates to fill their junior management positions. Why? Because with their broader education, they have been doing better jobs in management than those who are merely engineers. One company official said that his company would hire 100 out of 450 management candidates from non-technical schools during 1953, and that unless the engineers' training improved, that proportion would be increased. These are serious men talking about a serious problem. We need to take careful note of them. They but underline the importance of continually striving to improve our curricula, and they issue warning to those of us who hang back that we are but hurting ourselves.

Other Curricular Weaknesses

Two generally voiced complaints about engineering curricula are especially worth comment, it seems to me. One was that our curricula often contain much that is of no real value in industrial practice, that too much time is spent on "theoretical" aspects of engineering and too little time on practical training for industrial occupations, that we offer, in short, too few realistic and useful courses. Perhaps we should pay heed to that complaint, at least to the extent of applying a broom to the cobwebs in our curricular corners. The other complaint was that our curricula are weak in teaching students the art of self-expression. Neither in writing nor in speech do most of our graduates excel—I think we can admit it—and yet wherever they go in industry, they must necessarily write technical reports, if only for intra-office circulation, and address groups of people on engineering problems. No matter how well we do our job of training them in their specialties, they tend to lose their effectiveness on the job if they cannot clearly express their opinions and ideas. Company official after company official begged us to take back to our campuses the message that if we do nothing else, we should stress the art of self-expression in our teaching, even if in so doing we cut into the time we have traditionally given to engineering subjects.

Humility and Service

Finally, it was impressed upon me that we as educators should not forget that to a great extent in all aspects of industry it is still experience that makes the man. As we teach, we need not concern ourselves with training for perfection or for high executive position. Our function is a more limited one: to supply the solid foundations on which to build a career in industry. The career itself we must leave to each man, for only he will set the limits to his own eminence. But we can do something, nevertheless, to help him on his way up. In our classes, we can impress on him that he must not expect his engineering training alone, valuable though it will prove to be, to open all doors to success unassisted. We can instill in him the idea that to succeed in his job, he needs the basic knowledge we give him plus the will to work, to grow, to seek opportunity for service, and above all, to produce. Perhaps if we occasionally remind him that he will probably begin his industrial career with still more training, for perhaps as long as two years, during which time he will be of little use to his employer, we could emphasize the point! Such a reminder might serve also to remove a little of the "cockiness" that industry men all find so objectionable in our recent graduates.

In other words, we need to teach humility—to train in the ideal of service—to inculcate a self-propelling interest in work that will carry the student from the

lowest rung of the industrial ladder all the way up. We can boost him onto that first rung, but the rest he must negotiate for himself. If we can succeed in implanting this kind of approach to his job; if we can teach him that his successful future rests much more on himself than it does on what he learns from us, we will have met the obligations of our profession as we should. If, in addition, we strive to maintain the best curricula we can, as closely in line with industrial needs as possible, we can then be sure that we have done what we should in the cause of engineering education and American industrial strength as well.

Leading Hydraulic Engineers from Eighteen Countries Attend Minnesota International Hydraulics Convention

The Minnesota International Hydraulics Convention, which combined the fifth plenary meeting of the International Association for Hydraulic Research and the second separate meeting of the Hydraulics Division of the American Society of Civil Engineers, introduced several innovations in meetings of this character. It was held at the University of Minnesota in Minneapolis September 1–4, 1953, with many eminent scientists and engineers from eighteen countries throughout the world in attendance, as well as delegates from 35 states of the United States and the District of Columbia. Preceding the Convention by one day, there was also in session a Hydrology Meeting of the North Central Regional Branch of the American Geophysical Union.

A particularly unique feature of the Convention was the pre-publication of all technical papers in a monumental volume, elaborately illustrated by 550 diagrams, charts, and photographs, containing some 570 $8\frac{1}{2} \times 11$ size pages incorporating 49 comprehensive hydraulics papers by 75 authors from some 20 countries. The preprinting of the Technical Proceedings proved to be exceptionally effective in scheduling the technical sessions and stimulating discussion.

The theme of the Congress was directed toward four geophysical aspects of hydraulics as follows: (a) Basic Relationships of Sediment Transportation by Flowing Water; (b) Density Currents; (c) Air Entrainment by Flowing Water; and (d) Waves, Beach Erosion, and the Hydromechanics of Shore Structures. Countries participating for the first time since the World War in these sessions included Yugoslavia and Japan. A one-half day tour was made through the St. Anthony Falls Hydraulic Laboratory, displayed in full operation.

Training in Research*

By ROBERT L. PIGFORD

Professor and Chairman, Chemical Engineering Department, University of Delaware

The essential elements of "training for research" of the type used for education of students and for contribution to scientific progress seem to me to be:

(a) The existence of the right "atmosphere"
(b) Recognition of research accomplishments by students
(c) Proper definition of thesis objectives and occasional review of objectives.

The academic atmosphere will not be right for productive research unless the majority of the staff members is actively engaged in research as individuals. The atmosphere should be one in which there is frequent evidence of "ideas in the making," as J. H. Hildebrand describes the situation in a successful western university chemistry department.† If the staff is inclined to be excited about new things and about more thorough approaches to familiar principles the students are likely to follow. If the staff members are interested in each other's research work the students are likely to feel that they are members of a department-wide research family. There should be no intellectual autocracy. Each student should be taught to feel that he is entitled to question every result and conclusion of staff member and fellow student alike. Such criticism should be welcomed.

*Presented at the Dartmouth Meeting of the American Society of Engineering Education, June, 1952.

†J. H. Hildebrand, "The Making of a Teacher," *Chem. and Eng. News*, **30**, 2072–5 (May, 1952).

Research Seminar

The research seminar is an effective administrative device that can contribute to the proper atmosphere. If there is active interest of the whole staff in the thorough review of partly or totally completed research projects the students who present their plans, results, and interpretations will feel that they are making a worthwhile effort. The staff and students should participate in the discussions on an equal basis, the staff members behaving not as the students' judges but as their partners in a fascinating game. Occasionally, staff members should describe their own personal research to the seminar for criticism and comment by colleagues and students alike.

The success of such a seminar probably can be judged by the vigor of discussion or friendly argument that the presentation produces between members of the audience as well as between audience and speaker. Enough time should be devoted to each subject to give more than a superficial treatment of each problem; the intellectual interest often increases rapidly after more than an hour's discussion of a subject that may have been initially uninteresting.

Enthusiasm for Research

As in every field of creative endeavor, enthusiasm for research is greatest when those doing it experience recognition for work well done. There is probably no greater force driving a student to spend time at his laboratory bench or in his cubicle in the library than the expectation that his results will be acknowledged

eventually as being good and significant. Students who feel themselves to be "pairs of hands" are likely to behave as laboratory helpers without taking advantage of the unexpected observation and without reaching new conclusions different and better than the preliminary ones that have been handed down by their research advisors.

One essential element of a good graduate research project is intelligent initial planning. Students beginning their graduate study are too often convinced that a research program consists of collecting data from a certain piece of equipment operated at definite experimental conditions laid down according to a plan devised even before the equipment is constructed. Frequently it must be emphasized that the only suitable object for a graduate research program is the investigation of a physical principle or hypothesis. Usually the aim of a thesis can be expressed by asking a question, such as "Can thermodynamic free energies of ternary mixtures be predicted successfully from binary experimental data alone?", or "Is it possible to explain existing anomalous rates of gas absorption in liquids on the hypothesis of a resistance in the gas-liquid interface?" Such a question should be put to the student as early as possible; it may even be a good idea to ask him to write it down in his laboratory notebook along with an explanatory paragraph. He should be helped to realize that his assignment is to find an answer by whatever means, either experimental or theoretical, he and his advisor can jointly or separately devise.

On the other hand, most student theses require more assistance from a staff member than help with the definition of the problem. While theses reporting negative results are not necessarily bad the average student benefits much more from positive accomplishment. Usually it is unwise to suggest a problem to a student unless the advisor has done enough preliminary work on it by himself to be reasonably sure that acceptable and useful experimental and theoretical methods are available.

Academic research is fascinating work that requires some of the same qualifications for successful "direction" as does good class room teaching. The instructor who has the patience and sense of humor required to become a real colleague of his thesis advises is likely also to be one who senses the problems of his students in formal classes and who is remembered as a teacher who added something to the textbook.

A Forecast of Engineering Freshmen and Graduates During This Decade

By NORMAN N. BARISH

Associate Professor of Management Engineering and Secretary of the College of Engineering, New York University

What are the prospects of undergraduate enrollment during the rest of this decade? How many freshmen can engineering colleges expect? How many engineering graduates will be available to help meet industrial and military requirements? To help answer these questions, a series of statistical and graphic analyses were undertaken.

Relationship between Births and Male High School Graduates in the United States

Chart 1 [1] shows the relationship between male and female births and male high school graduates eighteen years later. The chart shows a steadily increasing per cent of persons graduating from high school. From 1928 through 1940 the per cent has more than doubled (from 9.6 per cent to 20.1 per cent). The war years caused a temporary reversal of this trend, but the trend of increased per cents of high school graduates has continued in recent years.

Only male high school graduates are used because the proportion of females entering engineering colleges is so small as to have no significant effect on total enrollment. The ratio of the two sexes at birth has been very stable from year to year at a level of about 1055 males per 1000 females.[2] There is, thus, no loss of accuracy in comparing male high school graduates with total number of male and female births. The only effect of using male and female births instead of male births is that the per cent of high school graduates to births eighteen years earlier is reduced by a fixed ratio (0.487).

Births are plotted on this chart to 1941. Using this birth data we would like to forecast the number of male high school graduates to 1959. A least squares trend line was computed using the percentages of male high school graduates to births eighteen years earlier from 1928 through 1951. This is indicated on the chart by the lower trend line. Forecasts were then made of the number of high school graduates from 1952 through 1959 by multiplying the extrapolated trend percentages by the number of births eighteen years earlier. These forecasts of high school graduates are indicated on the chart by the lower dashed extension line.

The deep trough which occurred during the war years in the number of high school graduates undoubtedly causes a somewhat downward bias in the least squares trend line just computed. To attempt to correct for this bias, an adjusted least squares line was computed, omitting the unusu-

[1] The number of births, male and female, is based on publications of the National Office of Vital Statistics. The number of male high school graduates was obtained from the Biennial Survey of Education. For the last three years (1949 through 1951) the number of high school graduates was based on Office of Education estimates published in *School Life*, 1951.

[2] Statistical Bulletin, Metropolitan Life Insurance Company, Vol. 33, No. 8, Aug. 1952.

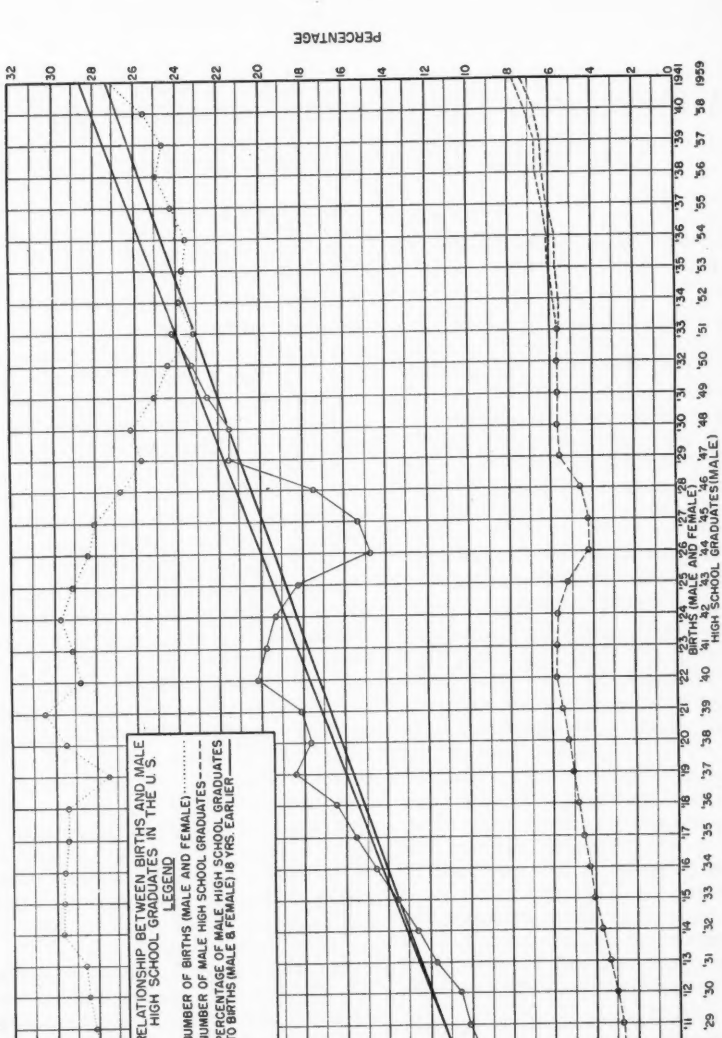

RELATIONSHIP BETWEEN BIRTHS AND MALE HIGH SCHOOL GRADUATES IN THE U.S.
LEGEND
NUMBER OF BIRTHS (MALE AND FEMALE)
NUMBER OF MALE HIGH SCHOOL GRADUATES
PERCENTAGE OF MALE HIGH SCHOOL GRADUATES TO BIRTHS (MALE & FEMALE) 18 YRS. EARLIER
NUMBER
PERCENTAGE
BIRTHS (MALE AND FEMALE)
HIGH SCHOOL GRADUATES (MALE)

CHART 1.

ally low percentages caused by the small high school graduating classes of 1944 and 1945. To be on the conservative side, the percentage for 1946 was included in the calculation even though its low value was undoubtedly caused to a great extent by the war. This adjusted line is indicated on the chart by the upper trend line. An adjusted forecast of the number of high school graduates based on this adjusted trend is indicated on the chart by the upper dashed extension line.

The forecasted number of male high school graduates based on each of these trend lines is indicated in the table below:

Year	Unadjusted Forecast	Adjusted Forecast
1952	565,500	588,900
1953	578,400	602,800
1954	580,700	605,900
1955	607,800	634,600
1956	642,000	670,900
1957	647,300	676,900
1958	685,000	716,800
1959	740,100	775,000

These forecasts indicate that high school graduations can be expected to surpass considerably all previous peaks in the very near future.

Proportion of Male High School Graduates Entering Engineering Colleges

Chart 2 [3] shows an increasing proportion of male high school graduates entering engineering colleges throughout the 30's and early 40's until the draft made serious inroads. The high per cent in 1930–31 of high school graduates entering engineering college might be explained by the lack of employment opportunities for high school graduates caused by the beginning of the Great Depression. The trough of the decline in the percentages from the post-war peak of 1946–47 caused by the veteran bulge was reached in 1950–51.

A least squares trend line was computed using the percentages of previous year high school graduates entering engineering colleges from 1935–36 through 1951–52. This is indicated on the chart by the upper trend line.

This trend line is undoubtedly biased upward by the extraordinarily high percentages caused by the large number of returning servicemen entering engineering colleges in the falls of 1946 and 1947. To attempt to correct for this bias, an adjusted least squares line was computed omitting the unusually high percentages for the years 1946–47 and 1947–48. This adjusted line is indicated on the chart by the lower trend line.

To obtain trend estimates of the number of engineering college freshmen, we multiply the extrapolated trend percentages for 1952 through 1959 by the previously forecasted numbers of male high school graduates. Two sets of trend values are obtained: (1) unadjusted trend values by multiplying the unadjusted estimates of the high school graduates with the unadjusted percentages entering engineering colleges; (2) adjusted trend values by multiplying the adjusted estimates of high school graduates by the adjusted percentages entering engineering colleges. The unadjusted trend values for the number of engineering college freshmen are shown by the upper dashed extension line and the adjusted trend values by the lower dashed extension line.

Forecast of Engineering College Freshmen

The forecasted number of engineering college freshmen based on each of these

[3] The number of male high school graduates was derived as explained under Chart 1. The number of engineering college freshmen was obtained from the journals of the ASEE. Data for omitted years was either unavailable or incomplete. From 1949 onward, enrollment data is restricted to E.C.P.D. accredited institutions. However, the institutions included in years previous to 1949 were almost entirely E.C.P.D. accredited institutions. Thus, this change caused an approximate 4 per cent reduction in the 1949 undergraduate enrollment figures as compared with what it would have been if no change had been made in the lists of institutions.

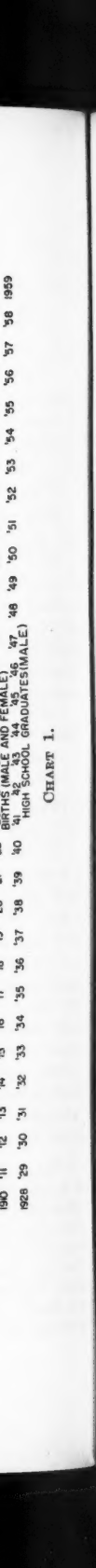


CHART 1.

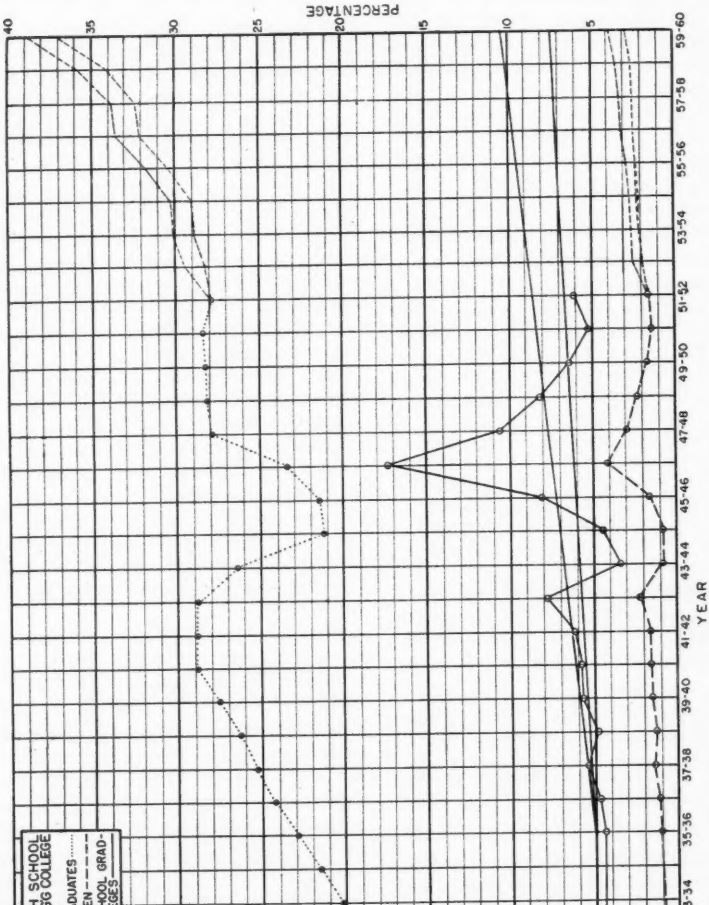

PROPORTION OF MALE HIGH SCHOOL GRADUATES ENTERING ENGG COLLEGE
LEGEND
NO OF MALE HIGH SCHOOL GRADUATES
NO OF ENGG COLLEGE FRESHMEN
% OF PREVIOUS YEAR HIGH SCHOOL GRADUATES ENTERING ENGG COLLEGES
NUMBER
PERCENTAGE
YEAR
1927-28
29-30
31-32
33-34
35-36
37-38
39-40
41-42
43-44
45-46
47-48
49-50
51-52
53-54
55-56
57-58
59-60

CHART 2.

trend lines is indicated in the following table:

Year	Unadjusted Forecast	Adjusted Forecast
1952*	49,800	39,900
1953	52,300	41,500
1954	53,800	42,300
1955	57,700	44,900
1956	62,400	48,200
1957	64,400	49,300
1958	69,700	52,000
1959	77,000	58,100

*These forecasts were prepared before the 1952 enrollment figures were available. Actual Engineering enrollment of 45,854 freshmen in 1952 turned out to be just about midway between these estimates.

This approach gives higher results than the commonly accepted analyses. The basic reason for the differences is that the commonly accepted methods usually imply that the same per cent of the age population will graduate from high school as at present or that even though this per cent may change, the proportion of those graduating who will be fit to choose engineering study will vary inversely with the change in the proportion of the age population graduating.

The method of Chart 2 is based on an extrapolation of the trend towards increased percentage of the age population graduating from high school as well as an increased percentage of those graduating attending engineering college. Displacement of the extrapolated trends gives a high and low range to the estimates on the chart. These forecasts, of course, have quite a number of limitations: they assume that basic trends of the past will continue into the future; being long term trend values, these forecasts do not account for many of the year to year variations; and any radical changes in the draft, manpower, and economic situations can easily upset these trends.

It is important to realize that extension of the trend line towards higher percentages of high school graduates entering engineering colleges cannot be expected to continue indefinitely. The proportion of students who have the intelligence level to be successful in engineering, the sciences, medicine, and other professions is rather fixed. Increases in the number choosing engineering must naturally impinge on the number available to choose the other professions. However, with increases in the proportion of persons graduating from high school, a larger reservoir of qualified manpower is available for professional training.

YEAR
CHART 2.

Student Attrition in National Undergraduate Engineering Enrollment

Between 75 and 95 per cent of our freshmen become sophomores, with a typical figure somewhere around 75 to 80 per cent. Between 60 and 75 per cent of our freshmen become juniors, with a typical figure somewhere around 60 to 70 per cent. Between 50 to 70 per cent of our freshmen become seniors, with a typical figure around 60 to 65 per cent.[4] The average per cent of first degree graduates as a proportion of entering freshman class was about 50 per cent in the 1930's. In the post-World War II years this percentage has risen to about 60 per cent of the entering freshman class.[5] The effects of the veterans returning with advanced standing and the greater maturity

[4] The effects of students dropping out for a year or more and then returning and of arts and science and business majors transferring into engineering schools with advanced standing, are not compensated for in these figures. A strict interpretation of these figures will, therefore, not permit the conclusion that they represent the probability of successfully completing courses of study in engineering colleges. The true probability is undoubtedly lower than these figures indicate.

[5] The figures for first degree graduates as a per cent of the entering freshman class ignores the effect of evening programs which graduate some students. This was necessary because the enrollment data does not show a breakdown of evening students by class or distinguish between the degrees received by day and evening students. Thus, to the extent that evening students have graduated, they exert a slight upward bias on these per cents.

of the returning veterans are undoubtedly partially responsible for the higher percentages graduating in these early post-World War II years.

Some attrition of engineering students is doubtless inevitable. A certain amount of attrition is desirable in order to maintain adequate standards. It is not possible to say whether the present attrition is too high without detailed study of the causes of this attrition. Certainly that part of the attrition which might be due to economic difficulties of the student represents an undersirable dilution of our manpower resources. (Some of the marked variations in attrition rates in the past 30 years are undoubtedly due to the sharply varying economic conditions and employment opportunities prevalent during the past several decades.) Any attrition which is caused by failure of the engineering colleges to motivate adequately the student is an undesirable occurrence. The responsibility for any such attrition, of course, rests squarely on the engineering colleges. Some attrition might also be due to inadequate admissions' screening procedures. A detailed study of the causes of attrition in engineering schools might yield valuable information as to the important causes of this attrition as well as provide the basis for an intelligent approach to this problem.

Forecast of Engineering Graduates

The importance of the attrition rate in determining the supply of engineering graduates in the future may be easily visualized by the table below which forecasts engineering graduates for the next ten years. The forecasts are made first on the basis of the pre-war attrition rates of approximately 50 per cent of the freshman class graduating. Then, a calculation is made using the post-World War II rate of approximately 60 per cent of the freshman class graduating four years after admission. Both forecasts are made on the basis of the analysis described in connection with Chart 2.

Forecast of Engineering Graduates Based on Adjusted Freshman Forecast in Chart 2

Year	50% of Freshman Basis	60% of Freshman Basis
1956	19,900	23,900
1957	20,700	24,900
1958	21,100	25,400
1959	22,500	26,000
1960	24,100	28,900
1961	24,600	29,600
1962	26,500	31,800
1963	29,000	34,800

Thus, the long term outlook for the supply of students for engineering education and the supply of graduate engineering talent to industry and government is not as bleak as some commonly accepted forecasts indicate. The engineering schools will have to gird themselves and prepare to meet this challenge for effective expansion of their programs. Industry and government will also need to make plans at the same time to absorb effectively this prospective larger number of graduating engineers.

The over-all growth of engineering enrollments at the undergraduate level during the past three decades has been very modest. Compared with the rate of growth of our industry and technology, this rate of growth may not be adequate for the long pull. No attempt has been made in this paper to gauge the demand for engineers. This demand varies widely with changes in the defense program and with economic conditions. Surveys frequently exaggerate the demand because employers in a tight labor market are apt to try to overhire to take into account prospective staff losses as well as the fact that they are never able to attain their full quota of the graduates for whom they apply. Labor pirating, of course, promotes this condition. Whether industry will have sufficient engineering manpower in the near future will depend to a great extent on the proportion of the graduating class which will be taken by the armed forces. Those graduating engineers who are inducted will not be available to industry until their discharge

several years later. Thus, short term availability of new graduates may be postponed by the armed forces manpower policies.

Engineering schools, industry, and government can cooperate in meeting the challenge created by the current shortage of engineering skills and promote the resolution of this manpower bottleneck. The establishment of sound policies for the utilization of existing engineering and technical skills in the most effective manner will help compensate for the shortages during the current period. The interest of American youth in engineering can be encouraged by public relations programs which explain the nature of the engineering professions and emphasize the leading roles they play in our society. Students whose natural abilities will enable them to be most successful in engineering study can be further encouraged to choose an engineering career by arranging for closer engineering college collaboration with the high schools. If the highly qualified high school graduates required in the engineering profession are to be encouraged to enroll in engineering schools, consideration should be given to the practicality of establishing long range employment plans which will allow enough variability to absorb the fluctuating number of engineering graduates which will be thrown on the employment market each June. Part of the drop in the proportion of college freshmen entering engineering colleges in some of the recent years has undoubtedly been due to the employment difficulties of some of our peak post-war pre-Korean graduating classes. This poor employment situation in individual years can repeat itself and do much to discourage qualified high school graduates from enrolling in engineering schools.

Sections and Branches

The **National Capital Area Section** of the ASEE held its Fall Meeting October 3, 1953 at the Johns Hopkins University, Baltimore, Maryland. Chairman Walther introduced Dr. Ralph Morgen and Mr. H. H. Armsby, the Section's representative on General Council, who reported on the 1953 Annual Meeting held at Gainesville, Florida June 1953. After various other announcements of coming section activities, the main part of the meeting was turned over to presentation of papers on the *Evaluation Programs* at various local engineering schools by the following:

1. *Howard University*—Professor Lee J. Purnell, Chairman of Educational Committee.
2. *George Washington University*—Professor John Kaye, Committee on Education.
3. *The Johns Hopkins University*—Professor H. E. Hoelscher, Committee on Education.
4. *The Johns Hopkins University*—Dean Robert H. Ray.

Professor Purnell said his committee took the philosophical approach, and came to the conclusion that more engineering students are needed and we must concentrate on this. Professor Kaye outlined his talk as follows: Objectives (Knowledge and understanding); Resources (curriculum, physical facilities, faculty, extra-curricular activities, methods of instruction); Achievements (evaluation of characteristics of students); and Recommendations. Professor Hoelscher talked about the Hopkins Program which is split into two curriculums—the operational or applied level (four years) and the Research or Theoretical Level (five years). Dean Ray spoke about the psychological and administrative problems of the Hopkins Program, giving advantages and disadvantages.

Types of Graduate Subsidy and Their Relation to Educational Values*

By ERNST WEBER

Professor and Head, Electrical Engineering; Director, Microwave Research Institute, Polytechnic Institute of Brooklyn

Graduate study in engineering has grown within the last 20 years from a few isolated centers to a scale which requires very careful reflection about its objectives and support. We all agree that graduate work is by far the most expensive part of a comprehensive program of engineering education and we appreciate that it cannot tolerate compromise with educational standards without loosing at once a great deal of its value.

However, all phases of human activity and endeavor are influenced by the socio-political atmosphere of the time. Surely, the very marked changes in social sensibilities in our life time have had some effect upon our concepts of education and our definition of educational values. Though, I am sure, we all realize these developments, I should like to review them briefly with some overemphasis in order to drive home the main point of my thesis.

The Social Reorientation

In these last 20 years we as a nation have turned from the social concept of "rugged individualism" to an objective occasionally defined as the "social welfare state." To be sure, differences of opinion as to degree still exist, but no political party in power can dare to undo the major changes in concepts of social obligation; indeed, many of these have become natural components of our attitudes.

Closely linked with this development is the change in concept of support of our higher educational system: from much endowment by few people to few institutions to a little support by all the people to all institutions! Implied is the conviction that agencies, whether federal or state, can distribute tax collections equitably and wisely. It satisfies social feelings to substitute group action for individual "arbitrary" decision.

But, in turn, it must now be required to give complete objective details concerning disposition of funds, because the responsibility is to a group of changing composition even though of fixed designation, rather than to an individual benefactor. Accounting procedures must be refined and made impersonal, extensive reports must be submitted, in short, patient paper work takes dominance over colorful individual demonstration of ability.

Finally, we need to recognize the psychological adjustment of the individual in this changing social pattern. Imperceptibly at any one time but inexorably nevertheless, the privilege of opportunity frequently becomes confused with an expected award and might even change in the individual's mind to a rightful demand.

Obviously, social change in itself is a healthy demonstration of the dynamic state of a nation. Like any dynamic process, however, it is more often than not of an oscillatory character and can carry beyond the appropriate momentary stable

* Presented at the Annual Meeting of ASEE, University of Florida, June 24, 1953 before the Division of Graduate Studies.

state. This must then stimulate certain reconsiderations.

Effect on Faculty Research

I am sure, we all agree that graduate study is inseparable from research. It is just unthinkable to have any worthwhile graduate program without strong faculty members interested in research and active in it. Thus, support of graduate work means essentially support of research. But this is precisely where the social reorientation has had its most profound effect.

Whereas it had been recognized that individually qualified graduate teachers should have their own laboratory facilities to carry on significant research and gather interested and qualified students as a small "school" around them—most institutions are now lacking the financial resources to support such programs as a matter of practical policy. Even the largest institutions in the country cannot afford the expensive research tools for the really fundamental research.

To the greatest part we have substituted sponsored research in programs of varying magnitudes but with stress upon team work and in many instances with closely defined objectives. Again, with full realization of the possibilities as well as the dangers, sponsored research must be accepted as the only presently available solution of an embarrassing dilemma: having stimulated graduate work to a point where it defines the prestige of an institution, we lack the means to carry through!

But we need to fully appreciate that the minimum sacrifice is a limited choice for the individual faculty member—unless he can associate with a project for which support is available, his chances for personal research are slim; and that the maximum danger is laboratory "employment" in research and development very much like in industrial laboratories with no personal choice of topic except as the recognized ability dictates.

Clearly, institutions should attempt to engage in sponsored research projects that contribute to the professional growth of their faculty and should be weary of carrying development programs merely to supplement faculty salaries.

Effect on Student Programs

The psychological effects of the social reorientation have been noticed in student attitudes. Whereas 15 and 20 years ago the student made a very weighty decision when he embarked upon graduate work and frequently anticipated years of struggle for a living and hard learning under the tutelage of a well-known contributor to research, he is now apt to stipulate how much time he might be able to spend on a degree program. To be sure, the general shortage of engineers, twice upon us within 10 years, has aggravated this situation. But it is not uncommon that a student might feel we owe him a degree and that he might take the demand for personal extraordinary effort as almost an imposition.

Because the sponsored research program can provide full employment together with the opportunity to carry forth graduate programs, students might select a line of least effort and maximum return —with the grave danger to consider as dissertation a well-written report on an assigned phase of a development program. But any good engineer would normally be expected to perform equally well just for his salary. It is up to us to realize the limits to which sponsored research can support the graduate research program without impairment of educational values and to jealousy guard the standards of achievement set for the advanced degrees. To a slight extent, I feel, we have already compromised in many places with respect to the requirements of a strong Master's program because of the increased number of students induced to take up graduate study either because it has been made a requirement for a position, or because of the larger reward in industry. Let us be sure to hold fast at least to the high standards of the doctoral programs.

However much we might deplore today the "rugged individualism," we must attempt to recognize in the advanced graduate student his best abilities, cultivate these and have them unfold to best advantage if we want to train leaders of tomorrow. However much we might exalt team work in research, we must attempt to spurn each member to his greatest efforts and give him the possibility of individual achievement. This requires diversification of a strong faculty, keen interest of faculty members in student progress, and an atmosphere of continuous alertness and growth.

Types of Support of Graduate Study

With this background it is almost self evident how I shall classify the various types of support of graduate study and research with respect to their relation to educational values.

Individual Faculty Research, supported from endowment, from research grants, from special gifts, with no specification of either topic or objective, should rank highest. Of course, this places the burden of award upon the department head or the dean, but it guarantees the maximum of flexibility for the best faculty members if the proper choice is made. Unfortunately, only a very small part of graduate research can be supported in this way because of the lack of appropriate funds.

Broad Research Fellowships rank next, and should in fact, be one of the strongest supports of graduate work. The student receives an amount adequate to sustain himself fully or partly, the institute receives an amount sufficient to cover tuition as well as research equipment and materials and preferably a contribution towards faculty research associated with the student's program. A broad topic is chosen by the student and eventually focussed by the faculty adviser. The Coffin fellowships of the General Electric Company, the DuPont and Westinghouse fellowships, as well as those administered by the National Research Council are excellent examples, but there are far too few of these at the present time.

Area Research Fellowships and Research Programs are quite similar to the previous group except that the area in which research should be done is specified. Excellent examples are the programs of the National Science Foundation and of the Office of Naval Research. In both instances, a proposal must be made by an institution stating broad objectives of the research and approximate scope of operation. Fellowships can be made part of the proposal, partial faculty services are included, and materials and supplies are covered. Since no restrictions are placed on publications of results, the educational value is still excellent; the only difficulty is the fact that concrete proposals must be made so that flexibility is wanting. A certain amount of accounting for the expenditures—less for National Science Foundation and more for the Office of Naval Research—is required. Similar fellowships are available from a few industrial companies.

Specific Research Fellowships are made available by certain industries for the exploration of rather specific topics, for the accumulation of specified data, for development of specific measurements or instruments. These fellowships can have educational value if carefully administered by a faculty member versed in the field. There are obvious difficulties of unsuccessful termination, of withholding publication because of patent interests, etc. which often militate against this type of research support.

Sponsored Research Projects represent today the largest single type of support of research in Universities and Colleges. If these projects permit the use of graduate students, place no restriction upon publications of the results, and provide challenging topics for the faculty they can materially assist in broadening the scope of graduate work and contributing to the professional growth of the faculty. If, however, the research program emphasizes development work with immediate

design objectives, considerable care must be exercised to avoid accepting the fulfillment of contract objectives as synonymous with proper objectives of graduate study. This will be particularly pertinent for classified military developments.

Research Centers and Research Institutes can be very valuable for the direct support of graduate work if and only if the leading research staff is closely integrated with the teaching faculty of the institution. Entirely separate organizations frequently develop their own policies and might not enhance the caliber and scope of graduate work.

Conclusion

The social reorientation in this country during the last 20 years has changed the concept of support of education and has brought about a change of attitudes and practices which might lead to ready acceptance of support of graduate work in engineering that actually has low educational value. I have attempted to review, in admittedly stronger terms than objectively justifiable, why these changes are potentially dangerous to the maintenance of high standards of graduate study and research.

ANNUAL MEETING

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University of Illinois **Urbana, Illinois**

Progress in the Humanistic-Social Division*

By STUART W. CHAPMAN

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If we have been bedeviled at times by the epithet under which we work or have laughed at the academic double-takes which have followed its use, let us neither regret nor be too amused. In a real sense the seed of our Division, upon whose progress I report today, came into existence when the famous Hammond Committee in its 1940 report coined the term "humanistic-social" to describe one of the stems of the ideal engineering college curriculum.

History

The seed was sufficiently fertile to produce an embryo organization in September, 1944, when President Harry Rogers of the Society for the Promotion of Engineering Education appointed an Executive Committee of eight men for a new Humanistic-Social Division. But in this case the war retarded a birth. While delivery of a normal, fully-formed, nine-month baby was scheduled for the annual convention in June, 1945, in fact, because of government travel regulations, only labor pains occurred. These took the form of the publication of a series of papers which had been intended for meetings of a new Humanistic-Social Division at St. Louis. Thus the expected birth did not finally occur until the Annual Convention of 1946. At the ceremony thirty-one men assisted, of whom twenty-six were engineers.

Our gestation period was thus rather long. Between the gleam in the eyes of the men on the Hammond Committee and the final event, six years passed. But the heritage was good; now, seven years later, the Division has passed adolescence and has reached the first stages of maturity.

To prove this assertion let me state (1) that the Division has grown physically and in independence, and (2) has carried on a program which has contributed significantly to our thinking about problems of engineering education.

Look at our membership. In 1946 it consisted of thirty-one men. In the last Directory of the Society, eighty-two names are listed under Humanistic-Social, while under the English Division are the names of fifty or sixty others whose fields or whose own specification show their association with us in fact or in spirit. We have grown all right, but we have also grown independent. Of our original thirty-one members only five at the most were non-engineers. Of our presently-listed eighty-two members, sixty-three are from non-technical fields. Furthermore, as one looks at the record, he is impressed with the degree to which we were once dependent upon our technical colleagues. They fathered us; they constituted the bulk of the earliest nominating committees; they sometimes provided as many as half our speakers. In later years we have been getting along pretty much on our own. The Division is now self-operating, self-governing, and self-motivating. Participation of engineers in its organizational functioning and in its meetings has declined proportionately. (N. B. This statement is a record and not a boast.) We have not left our home in the ASEE

* A paper delivered at a meeting of the Humanistic-Social Division, ASEE, in Gainesville, Florida, June 24, 1953.

but our decisions, whether good or bad, have come to be more and more our own.

Significant Development

And to show for it, we have something of which we need not be ashamed. The Division has carried on a program which has been significant in the development of non-technical education for engineering students.

Only partly in jest I say that the program of the Humanistic-Social Division at these annual conventions has afforded many a man an opportunity to place upon his record the giving of a paper or participation in the activities of a professional society. If this has meant a promotion for this man or greater job-security for that, it is not an inconsequential achievement.

But, of course, of far greater moment is the contribution thus made to those who have spoken and to those who have listened. Many a person, when faced with a paper at one of our meetings, has been forced to crystallize, clarify, and evaluate his educational philosophy, his approach to a particular course, or his conduct of a special activity far earlier and more effectively than he would otherwise have done. The rest of us have been the beneficiaries of this thought.

Here I speak not at all in jest. We all have often said that meetings of professional societies are nice to go to because of the people you see and because of the conversations you have outside of the meetings. Papers? Oh, yes, they provide an excuse for the convention. As regards the sessions of our Division I can agree on the first two points. The people and the non-curricular conversations are most satisfying. But so are the papers. Every convention I have attended so far has given me a lift; I have come away feeling encouraged. Believe it or not, the papers, because of their thoughtfulness, sincerity, and practical concern with the problems of teaching, have given much of that lift. And I know that I am far from being alone in this reaction.

The record of our achievement as a Division is to be found largely in our annual meetings. As a full-fledged division of the ASEE we are now holding our eighth session in connection with an annual convention. We have also enjoyed two summer schools of three days each, one at Seattle in 1950 and one at East Lansing in 1951. At these meetings the bulk of our work has been done.

A listing of the subjects of the papers given is interesting. A rough classification, which is complicated by the crossing of departmental lines and by non-descriptive titles, gives the following results.

General philosophy of HSS programs	10
Discussion of HSS requirements or descriptions of programs	9
Methods of program planning	6
Teaching of values	5
Human relations	5
Art	4
Literature	4
Social science (general)	4
History	3
Science	3
Extra-curricular activities	2
Psychology	1
Ethics	1
Personal integration of instructor	1

What we should conclude from this summary I leave to you. Perhaps another program committee will find some suggestions here. As I look at the list, I suspect at least that we could afford to talk about our instructors somewhat oftener than two percent of the time.

Publication of some papers from our meetings is certainly a desirable follow-up. While I have not made a complete check-up, my impression is that the JOURNAL OF ENGINEERING EDUCATION is tending to publish fewer than it used to. In some years as many as five have been printed there. This year I believe the record is one. Perhaps five was more than we had any right to expect, considering the number of divisions in the Society; I am sure that one is too few to maintain the desired interest in the work of the Division

among our own members *and* our engineering colleagues.

For this reason the recent publication under separate cover of selected papers from two annual meetings of the Division stands out as an important achievement. To John Shirley, to Thomas Farrell—and the State University of Iowa—and to what others I do not know—should go our thanks. This work certainly deserves continuation in the years ahead.

Evaluation

This bare statement of facts will refresh our minds regarding the history of the Division. But I am supposed to speak about "past progress." Such a topic requires some evaluation and evaluation requires a set of standards. How well have we done?

The Past

In order to obtain criteria, let's look at some of the aims of the Division as they were early stated, especially by our first real chairman, Director Edwin S. Burdell of the Cooper Union. From these statements we learn that the Division was supposed to

1. seek "grass roots" support by securing broad membership from technical and humanistic-social faculty and from administration.
2. concern itself with and promote discusion of integrated humanistic-social programs, courses, and subject matter.
3. promote discussion of problems of humanistic-social education at sectional meetings.
4. assist efforts of all who are interested in developing curricula, training teachers, and publishing papers.
5. help secure more "able, vigorous, stimulating" teachers.
6. secure more interest in our work by people outside of engineering, by members of the College English Association, societies of economists, historians, librarians, sociologists, etc., especially to arouse more interest in teaching engineers.

Now we have a more concrete basis for making judgments. Our membership shows that the "grass" of the "grass roots" support is filling in. Our record of papers given and the consistently high, even inspiring, quality of them shows that we have discussed well the general philosophy of humanistic-social programs, and methods of planning and integrating them, and have taken apart and put together again many specific courses to see how they could contribute to over-all objectives. The Division has encouraged discussion of problems at sectional meetings of the Society, if not by formal action of its officers, then by getting people together and encouraging them to individual activity. It has encouraged publication of papers. These are all significant achievements.

At the risk of being repetitious, let me emphasize that all of this has been particularly important because it has been so closely related to our major job, teaching engineers. Certainly we have talked in general philosophical terms, but always about a philosophy of teaching. All in all we have had a pretty good balance between the general and the specific. And pretty consistently a conventioneer has been able to go home feeling that he had learned something which he could use in his program and in his classroom.

The Future

I hope that we have been humane. Certainly we have been human, for we have not achieved all of our objectives. If what I have already said appears to have been a panegyric, I can perhaps balance it by a statement of certain places where we might do more.

As I state wherein we may have fallen short and suggest some possibilities for the future, please let no one be more embarrassed than I am. After all, as an officer of the Division I have had my chance to function. What I have to say

now is intended not as criticism but as proposal which may or may not deserve discussion.

I have feared lately that perhaps we were not pulling enough engineers into the meetings of the Division, even though in all of them we have engineers as speakers and as audience. It is true also that as we became more independent the technical men who fathered us have felt that their support was no longer so necessary; some falling away was to be expected. But, though we find little evidence that our support in engineering colleges is diminishing, we should watch that the interest of engineers in our convention activities does not drop too low.

And, as we have attempted in the past, we should continue to foster as much mutual understanding and respect as possible. Our success, after all, depends to a considerable degree on the close cooperation of technical and non-technical faculties; this cooperation must in turn be based upon an appreciation by each of what the other is doing. Perhaps some day it would pay for us to explore with technical divisions the ways in which the fields of each could contribute to the work of the other, and make this the subject of discussion at a convention session.

Some care has been exercised to draw into the Division people from a variety of fields in the humanities and social studies. Such attention was necessary because many of our early supporters were from departments of English out of which humanistic-social programs developed in so many engineering colleges. Certainly the more we can bring into our activities the stimulus of varied points of view, the more likely we are to achieve the objectives we have set for ourselves. Continued emphasis on this point is desirable, as can be easily seen by the relative paucity of papers in certain areas and by the few men from some fields who have attended our sessions.

We have not done enough, I should say to acquaint people in other professional societies with what we are doing or why. Such an expansion of a knowledge of our activities is needed for reasons which I need not detail. But certainly if it is good for us to bring people from many fields and from liberal arts colleges into our work, it should be equally desirable for us to go to all the world and preach our particular gospel. I believe we have not done enough to establish relationships with other professional societies or to get our people to try to give papers on their programs so that they may know what we are doing. On this particular occasion a real step is being taken by the cooperation of members of our group in the sessions of the College English Association. This type of activity we should emphasize more than we have in the past.

Training Instructors

Then the question arises as to whether we have done enough to solve problems of securing teachers for the programs we are developing. True, some years ago an investigation was made of the possibility of setting up a program of graduate study which would give special training for work in integrated curricula. This work was dropped, and perhaps rightly so. I myself blow hot and cold on the subject. But I always come back to the conviction that the matter is worth discussing again to see whether we still agree that we should continue taking our teachers from regular graduate programs and then giving them on-the-job training. Perhaps we could, if we concentrated on it, find some way to develop special graduate programs to take care of our special needs, if we agree that we have them.

Closely related to the problem of training instructors for the kind of teaching they may encounter in humanistic-social programs is the problem of their understanding of the technical work which their students are studying and will some day undertake professionally. If our students need to understand more of what we know, in order to be better men and citizens, perhaps we need to understand more of

their work and interests in order to be better teachers. As means to this end, we might explore two measures: (1) the encouragement of humanistic-social instructors taking or auditing technical courses, with all the attendant problems of standards for promotion and maintenance of professional standards, and (2) the participation of our men in activities of those industries which take faculty from technical colleges for full-year or summer programs of study. Possibly the problems involved in these two activities are too many for solution—but investigation of them might be desirable.

Meetings of the Division have shown a remarkable agreement on objectives of humanistic-social programs and have indicated a desire to get down to basic principles in all the fields from which we take material. Factual coverage, we have seemed to state, is less important than understanding and use of fundamental concepts. But just what are the most important principles which are contributed by the various fields of study? Could we find the means of helping each other by drawing up, over a period of years, a suggested list of basic concepts which we all could go to work upon?

System of Exchanges

One final suggestion. We of this Division have met yearly, have discussed our problems, described our programs and thus have given genuine help to one another. But this experience has been in a sense vicarious. We hear what others do; we do not get the chance to do what they do. How much more we could gain from each other if we could work together for a year instead of for a week. What, then, would be the possibility of our Division encouraging a system of exchanges so that some of us could, once in a while, live and work at another institution long enough to become a part of its program? Then we could take back to our own departments not just mimeographed papers or memories, valuable as these have been both to me and to many others; we could take back with us an understanding based on a living experience.

This has been but a brief review and evaluation of the past progress of the Humanistic-Social Division. But to many of us the Division has meant more than any paper could express. Were I to try to put that meaning into words I could do no better than John Shirley did in his introduction to the Selected Papers which the Division has just published.

"Those of us who have attended these discussions have been well repaid; we have been constantly heartened by the serious intent of the men responsible for planning for and instructing the future engineers in the area of the humane and social sciences; we have been frequently amazed at the general uniformity of our conclusions. This is not to say that all of us have thought alike or that a single mold of engineering education has evolved. But the purposes, the intents, and (generally speaking) the methods of approach which have seemed to work have been in greater agreement than we would have believed possible. If nothing else, these meetings of minds have strongly persuaded us that we are proceeding properly, and that the revolution in engineering education which is the reason for our Division's being is working in the right direction. We have been able to return home from these meetings with reinforced strength and with renewed convictions."

Validity of Examinations*

By IRWIN WLADAVER

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I'm going to talk with you about validity of examinations. My immediate purpose is to bring to your attention as clearly as I can the one central issue that in my opinion shows signs of serious neglect.

The issue, as I see it, is this: that validity of examinations is a social achievement and a social obligation. It is not a one-man job. And it is never possible to state that a test or examination (I use these words interchangeably) has 100 per cent validity. The best you can do is to strive to have your test achieve a high degree of validity and, consequently, to have it receive widespread acceptance as a valid instrument. The great problem, then, is (1) to realize that validity involves *people* and (2) that these people can all make contributions toward a *degree of validity* which, by its nature, is not susceptible to precise or even approximate measurement.

I don't want you to think I'm posing as an expert in psychological measurement. In fact I want to acknowledge my great obligation to four particularly useful sources. They appear in the partially annotated bibliography that I've appended to this paper and I hope you will consult them, and the other items, too, when you are ready to do some probing yourself. The four I'm referring to are these:

1. *Validity*, an unpublished paper by Dr. Louis E. Raths, of the New York University School of Education. This is a comprehensive treatment of validity, to which I am most deeply indebted. Besides, it's wonderful reading. I have been profoundly influenced by this work of Prof. Raths and I am grateful to him for his carte blanche permission to adapt his material.

2. *Educational Measurement* (E. F. Lindquist, ed.), a new and absolutely amazing symposium on every conceivable aspect of the subject, by the outstanding people in the United States. The American Council on Education published the book in 1951. Chapter 16, on Validity, is excellent and highly authoritative. Prof. E. E. Cureton of Tennessee and others contributed to the chapter. The rest of the book is equally high in quality and I earnestly recommend it to you for all aspects of educational measurements.

3. *Proceedings of the Engineering Drawing Summer School* (St. Louis, 1946). The whole section on examinations is particularly appropriate. The articles by Professors Vierck, Schuck, and Mann ought to be required reading and Professor Arnold's discussion that followed Dr. Mann's paper on validity was very much to the point of today's topic.

4. *Range of Human Capacities*, by Dr. David Wechsler, is a most provocative book, and anyone who is not afraid of an intellectual challenge to long-standing notions about human capacities ought to read it.

And so you see that the central issue I'm talking about is not a discovery of mine. Nor is it that writers and speakers have failed to mention it before the public. What usually happens, however, is that these persons point out the problem but rarely suggest a course of action that might conceivably lead to a minimum or tentative solution. I'm going to suggest

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some courses of action and see what happens—if anything.

My plan of approach is to delimit the problem, to state certain reasonable assumptions, to give acceptable definitions we can work with and some examples to show how the definitions work. Then we'll be able to attack the subject proper and —I hope—properly.

Delimitations

Here are the things I'm not going to do: I am not going to challenge the whole field of educational philosophy. I'm not going to take on the whole field of educational psychology. I'm not going to take an inexorable stand for or against "objective" examinations, although I do have some serious misgivings about how we arrive at grades for our students. Whether we use objective or non-objective methods of scoring tests or laboratory drawings, I have no intention of thrusting a lance into a windmill; I don't want to get knocked off my mule.

Assumptions

I'm going to assume that it's right to give examinations and to assign grades to our students. We don't have much choice, anyway, do we? Then let's make the process as useful and as meaningful as we can.

I'm going to make this important assumption: that educational measurement in engineering drawing and descriptive geometry has the following major functions, among others:

1. To facilitate learning on the part of our students.
2. To evaluate their work and progress toward the course objectives.
3. To aid in the improvement of instruction or, what is the same thing, to increase our own professional stature.
4. To assist us in counseling our students.

And I might as well add that these are not automatic.

I'm going to assume that, since we are experts in engineering drawing and descriptive geometry, and since we are professional teachers, it ought to be our job to make up examinations designed to serve any specific purpose we think is right; and that it's also our job to investigate the relative validity of these exams.

Definitions

The important words to define and differentiate are reliability and validity, as characteristics of examinations. First, *reliability:* it's easy to explain and easy to illustrate. Reliability is consistency. A test is reliable to the extent that the score will be the same when it is used as a retest—or when alternate forms of the same test are used. It is a matter of statistics *only.* If I score 60 on a test today and 60 on the same test tomorrow, then the test is 100 per cent reliable. It doesn't make the slightest difference what the test is on. The content is immaterial.

I'll give two more examples: If your watch keeps perfect time, but you happen to have set it fifteen minutes slow, your watch is perfectly reliable. Statistically, the reliability coefficient is unity. You may miss your class every day, but your watch is reliable in the sense we're talking about. Maybe you will have no job, but you have a reliable watch.

And if I tell you, day after day, that I caught a fish that long, the story is absolutely reliable as long as the fish neither stretches nor shrinks. Maybe I'm a liar, but I'm a reliable liar. You can depend on me to report the same lie.

Thus it is that reliability is a matter of statistics. A test may have a very high reliability coefficient and all that it means is that you are measuring consistently whatever it is that you are measuring. But high statistical reliability of an examination is no assurance that the exam has high, low, or any other degree of validity —or for that matter any validity at all.

The only connection between reliability and validity is this: If you can show by a number of non-statistical operations that

the test has certain kinds of validity, then proof of reliability is an additional piece of evidence in your claim for *greater* validity.

Validity

Now what do we mean by the word *validity*? To ask the question is to imply that it has a single, unique meaning. Unfortunately, this is not the case. It's easy enough to give a commonly accepted definition such as: "Validity is the extent to which a test measures what it purports to measure," or such as "The essential question of test validity is how well a test does the job it is employed to do." Both of these general statements are fine and no one quarrels with them. But from the standpoint of what to do, they are silent. They are not specific. They have no real meaning because they are empty of operations. What we have to know about a test or examination is this: what must we *do*, what steps must we *take* to determine its relative validity? Can I do it myself?

No. You can't do it yourself. No single individual can. If you look closely at the definition, you will see that human judgment is called for at every turn. The definitions say "how well," or " to what extent." The person who asks the question cannot also answer. It is true that an individual can do certain things himself. He can make tests of reliability, can get professional advice and can make improvements in the test arrangements and thus contribute to validity, but he alone cannot be the last word. Only through a period of time and use, in your school and in mine, can any test in a broad field like drawing achieve validity. For this reason, as I said at the outset, the determination of validity is a social achievement.

Let's suppose we have before us a test that we want to validate. There are four things, at least, we ought to consider and agree on. Otherwise we are beaten before we take a step.

1. We must agree on a definition of what we are trying to measure by the test.
2. We must agree on the responses that we shall consider evidence of the presence or absence of what we are trying to measure.
3. We must agree on what constitutes relative amounts of what we are trying to measure and on the way to estimate the probable error of measurement.
4. We must agree on the probable significance of the results in the general educational and professional growth of our students.

You can argue about any one of these four points—you probably do—but we must reach some workable and realistic compromise. It should be perfectly obvious, then, that a test-maker must be competent, capable of distinguishing the critical, the important, the relevant and the trivial elements. He must have no pet peeves and no pet devices that he feels he must spring at every opportunity. And of course he must be informed. Without these qualities, his judgment, for any intellectual purpose, must be suspect.

I said earlier that validity does not have a single, unique meaning. You should infer from this that the different concepts of validity depend upon the points of view from which you attempt to reach it. I'm going to cite eleven different, but sometimes overlapping, points of view from which to judge the degree and the kinds of validity which your test may have. Then I'll try to explain what I mean by each of them.

1. The extent of agreement between the test-results and some informed, competent criterion outside of the test.
2. The determination of validity through the use of criterion groups.
3. The extent to which predictions made on the basis of test-results come true.
4. The extent to which the operations required of the student—by the test —are in agreement with the title and the purpose of the test.

5. The extent to which the subject-matter content of a test is in agreement with the title and its implications.
6. The extent to which a test incorporates important items and excludes non-essentials, and how nearly the test parallels good teaching practice.
7. The extent to which a test contributes to the educational and professional growth of the student; that is, the extent to which a test reflects the career for which a student is presumably preparing, and the effectiveness of this kind of validity on counseling and advisement.
8. The extent to which parts of a test are themselves valid as part scores.
9. The extent to which the test correlates with other records—and the extent to which such correlation is of little use or even spurious.
10. The extent to which statistical analyses of the test and of individual items of the test contribute to validity.
11. The extent to which the actual construction of the test conforms to sound practice and so contributes this kind of validity.

1. *The extent of agreement between the test-results and some informed competent criterion outside of the test.*

By this I mean the judgment of competent persons who know the purpose of the examination. For example, ask a capable teacher to rank your students in order of merit with respect to the particular trait you are testing for. Naturally, this teacher should have opportunities to judge the students in action. Then give the exam and score it. If there is substantial agreement between the test results and this informed, competent criterion, then you have the right to say that the test has some degree of this kind of validity. Naturally, the teacher who has done the ranking ought to be competent and informed and ought to know what can be expected. Generally you will have such persons working with you.

Sometimes individual ranking isn't possible, for one reason or another. In such a case, have the students divided into a number of groups, say five: excellent, good, average, below average and poor. And then give the test. Divide the test-scores the same way and see whether your "excellent" students make "excellent" grades, and so on down the line. If your "excellent" students make "average" scores, you may want to take some steps. If your "excellent" students make "poor" scores, you draw your own conclusions; surely some changes are in order. Perhaps you may come to believe that the other fellow's judgment was not good and that the test actually had high validity from the standpoint of teacher-opinion. That's up to you. But you can see why it's important to select a competent and informed criterion that you can stick with.

2. *The determination of validity by use of criterion groups.*

By a criterion group I mean a group of persons actually working in the field for which our students are preparing. If you say you are training for draftsmanship, select draftsmen for your criterion group. If you say you want to teach your students what a good engineer ought to learn from your drawing and descriptive geometry courses, then select engineers, preferably not your former students. The group you select should depend on the goals and objectives you say you have been trying to reach. Presumably the persons you select for your criterion group will be homogeneous; with respect to what you want to know, their behavior will be similar.

What you want to know is this. How did your school work in drawing help you in your present work? Was the information useful? Were the experiences useful? Have you any suggestions? What are your attitudes? What mistakes did

we make? These are just a few off-the-cuff samples of questions you might ask.

To the extent that there is correspondence between your test-results and important factors related by your criterion group, this kind of validity may be present.

I must point out some dangers in this procedure. Oftentimes young graduates, especially your own former students, will tell you what they think you want to hear; especially what a terrific job you did on them. Believe it, if you must. But it doesn't give you much precise help.

Sometimes it does. A few weeks ago, my daughter said to me, "Dad, what's a left-hand screw-thread?" Naturally, I started to explain. But she added, "I really don't care. All I wanted to say was that I met a boy" (of course I was glad to hear this), "a boy who had you in drawing six years ago. The only thing he remembers about your course is that you used to drive a taxicab nights when you went to college and that one of the wheels of the Yellow Cab Company cars had a thread that went the wrong way and you didn't find out for an hour after you got a flat tire." This he remembered.

So I say this kind of information may be useful in your quest for validity of examinations and it may not.

3. *The extent to which predictions made on the basis of test-results come true.*

If high grades in a drawing test were fairly sure indications that a student would be a successful engineer or draftsman, you could say the test had high validity of this kind. That is, you could make predictions that would be verified in action. Isn't this what intelligence tests and aptitude tests mean to do? If they fail to predict fairly accurately, they lack this important aspect of validity.

This ought to be a good topic to investigate if you have a comprehensive test in drawing or descrip. See how closely your test-results correlate with the graduating averages of your students. Maybe there is some predictive validity present. And if there is, be sure you don't claim a cause and effect connection.

4. *The extent to which operations required of the student—by the test—are in agreement with the title and the purpose of the test.*

To me, this seems like the most important step of all in the search for evidence of test validity. Suppose you were giving a test in a student's understanding of the principles of sectional views. If you wanted to know whether he could identify a properly drawn sectional view, given two exterior views, this would be one kind of operation at an easy identification level. (I recommend Prof. Graney's illustration along these lines on page 343 of the 1946 Summer School *Proceedings.*) How *much* validity an identification test has for what you are after is certainly open to question, but it surely has *some.*

If, however, your test requires that a student draw an indicated Section A–A, your test is likely to have *more* validity for an understanding of the principles of sectioning. And if you go all the way and say, "Draw the most useful section of the object," then you are really in for it. You have to presuppose all sorts of things and hope that the student's judgment coincides with yours.

The point I'm trying to make is this: if you say the test is a test of a student's ability to think, you ought to be able to show that it does indeed measure that ability. This will take some doing.

If you dare to say that the examination is a test of a student's ability to think *creatively,* I urge you to define your terms with scrupulous care and then show evidence that the test does indeed measure *that* ability.

This is a good time to remind you that students in some subjects forget from 40 to 80 per cent of the facts they once learned within three months to three years. If your test is designed to ask for facts only—and it's a perfectly justifiable kind of test—you should realize that *what* a student learns is not so important as *how*

he learns it. I think Professor John Rule's article in the May, 1953, *Journal of Engineering Drawing* carried this same implication.

To the extent that the mental operations of learning are called for on an examination, a claim for test validity can be reasonably supported.

5 and 6. *The subject-matter content of* a test can readily be checked against tables of contents of good textbooks; and comprehensive sampling of the field. If that's what you want, it's not hard to demonstrate. Also, if you consult with a few of your colleagues it will not take long to eliminate most of the trivia. But don't think that therefore your test is necessarily valid. All you have done is added a little weight to the balance. And you should be careful not to introduce into an exam unusual or new elements that you have not dealt with in class unless, of course, you think they are reasonable outcomes.

7. *Tests* in our field of engineering drawing and descriptive geometry can contribute solidly to professional and educational growth of our students by *reflecting the career* for which they are preparing. It may be clear to you what an important influence on our counseling duties a good test can have. It should warn us not to try to play the part of an all-wise deity, lacking omniscience as we do, but in some fields tests have reached the quality that permits advisors to make recommendations that otherwise could not be justified.

Whether our examinations are yet good enough is something else, but this is a kind of validity we should certainly strive for.

8. When *parts of a test* are *valid as part scores,* there are obvious advantages to the student who wants to know what partial progress he has made and also to the teacher who can be reasonably sure where deficiencies in learning and teaching exist. This is another kind of validity in the overall worthwhileness of a test.

9. *Correlations are often reported as evidence of test validity.* I'll go along with some. For example, if a test has a high reliability coefficient, there is no automatic assurance that the test is valid, but only that it has the kind of validity that self-consistency offers. However, if a test has a low reliability coefficient, then the test validity for any purpose must be seriously in doubt.

But there are other correlations that serve little use. Don't condemn a test simply because it doesn't correlate well with other records—high school records, for example. And more than anything else about correlations: don't attribute high validity to a test on the basis of its high correlation with another test assumed to be valid. As I see it, this begs the whole question of validity. An assumption of validity may be necessary—we do it all the time. But trying to prove validity by correlation with something assumed to be valid hardly seems the way to go about it. This is an understatement.

10. I shall probably lose some friends when I say I'm quite uncomfortable about the next matter. This has to do with *test-validity contributed by statistical analyses* of the test and of items in the test.

I guess I don't actually understand some of the statistical manipulation. Most of the formulas, unless I'm mistaken, make an important assumption: that the trait being tested is normally distributed. I have seen no evidence that this is true in drawing. And there are other assumptions, generally not expressed, that seem to me to have shaky foundations. In addition, most of them involve nasty and forbidding algebra.

For these reasons I question the usefulness of some of the statistical analyses in the claim for validity. If you are interested in statistics, read Professor Cureton's article called, "Validity, reliability and baloney." You'll find it listed in my bibliography.

11. The last item has to do with the *validity* contributed to a test *where a test is made up in conformance with sound and informed construction practice.* This is a matter about which any interested

person can be well posted if he takes the effort. In the bibliography I cite a small number of articles you may wish to read. They are on such subjects as: scoring examinations; problems in the use of answer blanks; examination fear; comparisons of true-false, multiple choice, completion-questions; and other related topics. And all of these have to do with validity to a greater or lesser degree.

Conclusions

Well, these are most of the operations reported in the literature on validity. There are only these last two brief but tremendously important points I feel I must make.

First, we must be constantly aware of the educational purpose of every test we give. The best way to stay alert to this is to state its purpose so that we can try to evaluate its influence on validity. Examinations to determine grades are certainly necessary, but a far greater purpose—perhaps the ultimate purpose—is the development in our students of resourcefulness and ingenuity.

Second, we are not hermits. Our students are working at their careers all over the country and all over the world. We are not even preparing all of them to practice engineering. We must test for knowledge, of course. But we should be testing for the kind of knowledge that leads to informed, socially desirable action. One way we can come close to this objective is to work out our testing problems together—actually to send copies of our examinations to colleagues in other schools, to use the exams in our classes, to criticize unstintingly and suggest improvements—and to accept such recommendations in a grateful spirit.

Wouldn't it be wonderful if we could say something like this: "Yes, we've trained these young people pretty well so that they can get off to a good start in the engineering profession. But more than that, we've helped them along to an education that will help them to live useful, productive, fruitful lives in any activity they ever choose." If our examinations have the kind of validity that will let us believe that this is really true, then we can indeed be proud of the work we are trying so hard to do.

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Minutes of General Council

A meeting of the General Council of the American Society for Engineering Education was held Wednesday, October 14, 1953, at 2:00 P.M. in the ASCE Board Room of the Engineering Societies Building, New York, N. Y. Those present were: L. E. Grinter, *President;* W. L. Everitt, B. R. Teare, Jr., E. A. Walker, W. C. White, *Vice Presidents;* A. B. Bronwell, *Secretary;* G. W. Farnham, *Treasurer;* J. M. Apple, H. H. Armsby, H. R. Beatty, C. A. Brown, N. A. Christensen, W. L. Collins, W. W. Dornberger, T. H. Evans, O. C. French, G. W. Gleeson, W. P. Godfrey, S. C. Hollister, H. K. Justice, H. Kuenzel, H. R. Lissner, G. D. Lobingier, G. A. Marston, R. S. Paffenbarger, H. P. Rodes, Thorndike Saville, R. J. Seeger, J. W. Shirley, E. B. Stavely, L. E. Stout, R. L. Sumwalt, N. D. Thomas, R. W. VanHouten, R. E. Vivian, K. F. Wendt, C. L. Wilson and M. Long.

Report of the Secretary

The Secretary reported the following:

1. Most of the ASEE Committees have been appointed for the year.

2. A number of the Divisions and Committees had taken advantage of the Fall Meeting program to get their executive committees together to discuss the projects for the year.

3. The Membership Drive this year will be conducted by the YET Committee. The Secretary urged that members of the Council and Deans back up the YET Committee in this activity.

Report of the Treasurer

The Treasurer presented the Statement of Receipts and Disbursements for the First Quarter of 1953–54. Both income and expense items seem to be in line with the budget. The University of Florida has rebated $527.27 as the excess of income over expense for the Annual Meeting.

Airforce ROTC Quotas

Vice President Everitt stated that the ECAC had been called upon to consider the problem of whether or not the Air Force ROTC had committed a breach of contract or moral commitment in reducing its quota of ROTC Students. He pointed out that a year ago, the Air Force had set very high quotas for its ROTC program but now it has drastically curtailed this program after having induced college students to participate. A study by Dean Easton, Chairman of the ECAC Military Affairs Committee showed that:

1. The Air Force ROTC contract which the student signs does not commit the Air Force to continuation of the student's ROTC program;

2. The ASEE had objected to the very large ROTC quotas set by the Air Force last Fall, hence any reproaches to the Air Force at this time would be a reversal of previous ASEE policy;

3. A survey of deans of some of the engineering colleges indicated that they did not feel that it would be wise to protest the ROTC reduction.

In view of these findings, the ECAC took no action in the matter.

Activities of ECRC

Vice President Walker discussed the activities of the ECRC and stated that the theme "Creativeness in Engineering" has proved to be a very popular subject and would be given considerable emphasis by ECRC at the Annual Meeting. He also stated that the ECRC had sold 800 copies of the Directory of Research, published last June, which has received exceedingly favorable reviews.

Plans for the Annual Meeting

Vice President White summarized the recommendations of the Committee on Annual Meeting relating to the program for the University of Illinois Meeting in June as follows:

1. The Committee proposed a continuation of the plan for General Sessions which was used last year.

a. A General Session to report on some of the prinicpal Society projects on Monday afternoon (some Division Conferences can be scheduled concurrently with this General Session);
b. A General Session of the Society on Tuesday morning;
c. General Sessions on Wednesday and Thursday mornings sponsored by the ECRC and ECAC;
d. General entertainment on Wednesday evening;
e. The Banquet on Thursday evening.

Proposed Amendment to ASEE Constitution and By-Laws relating to Dues of Individual Members

The recommendation of the Committee on Society Finances relating to a change in the dues status of individual members in order to provide adequate income for Society operations was reviewed.

The Secretary stated that the new proposal would establish a two-step dues structure based upon the age of the individual member, with the dues increasing automatically when the member becomes 36 years of age. The previous dues plan was based upon academic rank, necessitating a time-consuming study of the membership records each year in order to determine changes in academic rank before the dues could be evaluated for individual members. The proposed plan would eliminate this office procedure. The following amendments were voted by the General Council:

Amendment to Article XI—Section 2

Present Wording: The annual dues shall be as stated in the By-Laws of the Society, and any change in the dues of individual membership shall be determined by letter ballot of such membership.

Proposed Amended Wording: The annual dues shall be as stated in the By-Laws of the Society.

Amendment to By-Law IV:

This By-Law now specifies the dues of individual members as: $5.50 for Librarians and grades under Associate Professor, $6.00 for Associate Professors and $7.00 for all others.

Proposed wording of Amendment: "The dues of members shall be established annually by the General Council at the same Council Meeting at which the annual budget is adopted. The dues shall be adjusted within the ceilings hereby established so that over a reasonable period of years the Society shall not incur a deficit that in the opinion of the General Council might endanger its continuity of operation. The increase of dues approved in any one year shall not exceed $1.00 for either grade of membership described herewith. The ceiling on dues shall be $7.00 per year for those who have not reached their 36th birthday at the beginning of the fiscal year (July 1) and $10.00 per year for all other individual members."

Amendment to By-Law IX

Present wording of By-Law: The dues of individual members may be changed only by a favorable vote by letter ballot of individual members.

Proposed amended wording: The ceilings of dues of individual members as specified in By-Law IV may be changed only by a majority vote by letter ballot of individual members.

In the discussion that followed, it was pointed out that if the dues of individual members were increased to $8.00 for members over 36 years of age, and $6.00 for members under 36 years of age this would provide adequate finances for Society operations at the present time.

The General Council voted unanimously to approve the foregoing amendments to the Constitution and By-Laws and authorized the Executive Board, after consultation with the Committee on Constitution and By-Laws, to adjust the wording to avoid possible confusion and misunderstanding. The Council agreed to an inclusion of a statement specifying the dues for the year 1954–55 in order to provide the necessary transition from the academic rank basis to the age basis of levying the dues.

Evaluation of Engineering Education

President Grinter summarized the latest developments of the Committee on Evaluation of Engineering Education, stating that three of the Sub-Committees had completed their preliminary reports and that these were being mailed to the Deans of Engineering Colleges and the Chairman of the Institutional Committees for their comments and suggestions for improvement. These

criticisms will be analyzed by the Secretary of the Committee on Evaluation of Engineering Education. This analysis will be available prior to the next meeting of the Committee on Evaluation of Engineering Education, at which time the final report will be drafted.

Dr. Seeger, Chairman of the ASEE Physics Division, stated that the Physics Division had called a meeting of the Sub-Committee on Physics of the ASEE Committee on Evaluation, together with the Executive Committee of the ASEE Phyisics Division and the AAPT Committee on Physics in the Engineering Curriculum. This meeting recommended the following: (1) That the Deans of Engineering Colleges and the Chairmen of the Physics Departments be asked to appoint local joint committees to study the place of Physics in the Engineering Curriculum. (2) That the report of the Committee on Evaluation of Engineering Education withhold final judgment on matters relating to the teaching of Physics until there has been widespread discussion of this problem among engineering and physics teachers (3) That a joint meeting of the Physics Division of the ASEE and several curricular committees be planned for the Annual Meeting of the Society to discuss both the prospects of including fundamental material in the newer areas of Physics in the Engineering Curricula and also the possibility of achieving better integration of Physics in Engineering courses at the freshman or sophomore level. (4) The Committee recommended that a joint symposium on this subject be arranged for the AAPT meeting in January.

ASEE Sponsored Summer Institutes

The Secretary reviewed the recommendations relating to the Summer Institute Programs resulting from the morning meeting with the Chairmen of Divisions and representatives of the General Council. The objective of this program is to identify those areas where science and technology are moving rapidly ahead and where there appears to be opening up vast areas of new fundamental concepts which may be translated into significant engineering practice in the years ahead. Conferences would then be arranged in these particular areas to explore the subject matter from a teaching viewpoint. The conference in the morning recommended the following:

1. Approval in general principle of the plan of holding Summer Institute Conferences.

2. All proposals for Summer Institutes shall be submitted by one or more Divisions of the Society to the Executive Board for approval.

3. No attempt shall be made either to develop a Summer Institute program or solicit finances without prior authorization from the Executive Board.

4. After approval of the Summer Institute program, the participating institution or institutions may seek funds for financing the conference, within the general principles approved by the Executive Board.

5. An objective of the Summer Institute Program is to encourage publication and widespread dissemination of the results, including the possible preparation of textbooks in the field.

6. The Summer Institute Programs can be jointly sponsored by other societies participating with ASEE, but the ASEE should have primary responsibility for such conferences in order to assure that the efforts will be directed so as to achieve best results for the purposes of engineering education.

Progress Report of Committee on Society Functions

Vice President Teare summarized the present thinking of the Committee on Society Functions. The Committee is endeavoring to seek a better two-way flow of ideas between the General Council and members of the Society. It is seeking to make individual units in the Society more effective. It is considering the relationships of the Council, Divisions, Committees and Sections of the ASEE from the standpoint of achieving best operational results. It is giving consideration to the service of the Society to the individual member.

Council members discussed the possibility of having the Chairman of the Division serve as a Member of the General Council in order to improve the liaison between the Divisions and Council. Several of the Council members stated that the practice of their Divisions was to elect a past chairman to serve on the General Council. In this way the representative on the General Council

is fairly well informed of the Division operations.

President Grinter asked for the consensus of opinion as to whether or not it was desirable for the Chairman of a Division to serve as the Council representative. The majority view of the Council opposed this plan.

The Council discussed the possibility of redefining the boundaries of Sections in order to make it possible for younger teachers to attend. It was suggested that the reason why Young Engineering Teachers do not attend Section meetings is because they do not feel they have a part in the meeting. Having no participation in the Section meetings, they have no reason for developing an interest in Society activities. President Grinter strongly urged that the Sections take steps to bring the younger members of the Society into active participation in Section meetings and that other areas of Society operations do likewise.

The Council requested that the Committee on Society Functions study specifically the problem of how younger faculty members can be better integrated into Society activities.

ASEE Sponsored Summer Schools

The following summer schools have been proposed by ASEE Divisions to be held at the University of Illinois either prior to or immediately after the Annual Meeting.

1. A Summer School in Machine Design has been proposed by the Mechanical Engineering Division, to be held during the week following the Annual Meeting. This will deal with various aspects of teaching Machine Design subject material.

2. The Mechanics Division has proposed a Summer School on graduate study in Engineering Mechanics and its relationship to undergraduate instruction. This Summer School would be held on June 11–12 prior to the Annual Meeting.

3. The Humanistic-Social Division has proposed a Summer School on Friday and Saturday following the Annual Meeting in order to develop the proposed project on Humanistic-Social Studies.

4. The Educational Methods Division and the General Electric Company have jointly proposed a Summer School to be held at Schenectady for a limited number of young instructors to acquaint them with teaching methods used in the advanced engineering course at the General Electric Company.

5. The Engineering Economy Division has proposed a Summer School to be held on June 13–14 dealing with analytical tools in engineering economics, including: (1) operation research, (2) accounting and economics.

The foregoing Summer Schools were approved by the Executive Board and the General Council.

Joint Conference with Instrument Society of America

The Instrument Society of America has proposed a joint conference on the teaching of instrumentation to be held on Saturday preceding the Annual Meeting at the University of Illinois. This would be a one-day conference, the program being arranged jointly by ISA and ASEE. The Executive Board and General Council voted to authorize ASEE sponsorship of this Conference.

YET Paper Contest

The Secretary reported that the Executive Board suggested continuation of the YET contest and had authorized two awards at $200 and $100 to be known as the "President's Award," which will be presented at the Annual Banquet to the wininng entries. The rules of the contest as published in the October issue of the JOURNAL are similar to those of last year, except that the method of judging the papers has been simplified. All papers must be submitted before March 1, 1954, to the Chairman of the ASEE Section in which the author resides.

Life Memberships

The General Council voted to grant life membership to the following members who qualify:

J. A. Van Den Brock	Leroy A. Wilson
M. O. Withey	Leonard A. Doggett
F. H. McClain	Joseph S. Lambie
Harold C. Bird	Arthur G. Gehrig
F. M. Marquis	Morland King
W. H. Hall	J. B. Kommers

Jerome W. Howe

Associate Institutional Membership Applicants

The Executive Board and General Council voted to grant Associate Institutional Mem-

bership to the following companies:

1. The Cleveland Electric Illumination Company
2. Ethyl Corporation Research Laboratories
3. Rome Cable Corporation
4. Weston Electrical Instrument Corporation
5. Public Service Electric & Gas Company

The Executive Board and General Council also voted to grant Active Institutional Membership to the University of Wichita.

Dues of ECPD

The Executive Board and General Council voted to increase the annual appropriation to ECPD to $700 as requested by ECPD.

Respectfully submitted,
ARTHUR BRONWELL,
Secretary

Reprints Available . . .

Are you interested in receiving copies of the newly completed "Manual of Graduate Study" or the "Report of the Committee on the Improvement of Teaching"? Copies of these can be obtained from the Secretary's Office, the price of the Graduate Manual being 50¢ and that of the Report of the Committee on the Improvement of Teaching being 15¢ each or $8.00 per hundred. All orders should be accompanied by a check remittance.

THE T-SQUARE PAGE

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Dear Colleagues:

I wish to take this opportunity to extend to you a cordial invitation to be present at the meetings of the Drawing Division during the coming year. With the present trend towards changes in the engineering curriculum, you cannot afford to miss the two meetings of the Division this year.

The program of the Midwinter Meeting as arranged by Prof. Jorgensen in cooperation with your chairman, and being held at the University of Pennsylvania has been planned with the objective of the technical and cultural development of the engineering drawing faculty.

Also, do you realize that this is the twenty-fifth year that the Division has held independent meetings, and that we are one of the largest divisions of the A.S.E.E.?

These thoughts are receiving serious consideration in the planning of the June meeting.

Your Executive Committee selected Philadelphia for its Midwinter Meeting because of its accessibility and the excellent facilities for technical and cultural trips.

After looking over the fine program, I am sure you will say with me—"I just can't afford to stay away."

I hope to see you in Philadelphia, so be sure to save the dates.

Sincerely yours,

Ralph T. Northrup, *Chairman,*
Drawing Division, A.S.E.E.

* * * * * * *

Midwinter Meeting of the Engineering Drawing Division of the A.S.E.E.

University of Pennsylvania, Philadelphia, Pennsylvania
January 28, 29, and 30, 1954

Thursday, January 28:

6:00– 8:00 p.m. **Executive Committee Dinner and Business Meeting—Bishop White Room, second floor, Houston Hall**

Friday, January 29:

10:00–12:00 noon — General Session—Room 314 Engineering Building

Chairman: Professor John G. McGuire, Texas A. & M. College

Technical Papers:

(a) "The Design of Inflatable Boats," Mary Blade, Assistant Professor of Engineering Drawing and Machine Design, Cooper Union, New York, Ellis Blade, Consulting Engineer, New York

(b) "Drafting Problems in Industry and Some Solutions," R. W. Pearson, Manager Operations Programming Section, Engineering Products Department, Victor Division, R.C.A.

Discussion:

12:15– 1:15 p.m. — Luncheon and Business Meetings—Smith Room, second floor, Houston Hall

Presiding: Professor Ralph T. Northrup, Chairman Drawing Division A.S.E.E.

6:00– 7:15 p.m. — Annual Dinner (Ladies Invited)—Smith Room, second floor, Houston Hall

7:30– 9:00 p.m. — General Session—Auditorium, second floor, Houston Hall

Chairman: Professor Albert Jorgensen, University of Pennsylvania
Technical Papers:

(a) "Specialized Drawing Courses Above the Freshman Level," Professor Randolph P. Hoelscher, General Engineering Drawing, University of Illinois

(b) "Drafting Problems in the Bearing Industry," Sven Neilsen, Assistant Chief Engineer, S.K.F. Industries, Philadelphia, Pennsylvania

Discussion:

Saturday, January 30:

9:00–11:30 a.m. — General Session—Room 314 Engineering Building

Chairman: Professor Theodore T. Aakhus, Vice Chairman, Drawing Division A.S.E.E., University of Nebraska

Technical Papers:

(a) "Graphics for Non-Engineers," Professor R. W. Parkinson, The Ohio State University, Columbus, Ohio

(b) "Vanishing Points and Shadows in Three Point Perspective," Professor Wayne Shick, University of Illinois

(c) "Three Dimensional Nomograms," Professor Douglas P. Adams, Massachusetts Institute of Technology, Boston, Massachusetts

Discussion:

11:45– 1:00 p.m. — Luncheon (Ladies Invited)—Smith Room, second floor, Houston Hall

Candid Comments

What Can the Engineering School Do About It?

Reflections on J. R. Snell's Article "Let's Clean House" *

By W. E. HOWLAND

Professor of Sanitary Engineering, Purdue University

The corruption, revealed in this article, which results from collusion between public officials and business enterprisers is of course shocking—it always is. Civil engineers are especially concerned to read this bitter indictment of the construction industry, with which they must, of necessity, work very closely. The real shocker, however, is the accusation of moral turpitude of the engineers themselves. One wonders how far the ethical corrosion has extended into the structure of the engineering profession.

Our students wonder, also, when they hear of such stories as these; and they do! There can be no doubt that many of our most promising young men have thus been dissuaded from the pursuit of civil engineering, especially from construction and from those branches most exclusvely concerned with public works.

I have no additional facts to help determine how great the moral damage to engineers has become, a question that naturally arises from reading so disturbing a paper, but I would like to point out that the evidence submitted should not cast suspicion upon the rank and file of the engineering profession,—that is to say upon the men who do the work. Nor, I believe, was it intended to do so by the author. There is little indication in the article that the young men fresh from engineering college are so weak in moral fiber, so destitute of professional idealism, or so uninformed about ethical principles as readily and rapidly to fall into the evil practices here exposed. Furthermore they do not have the opportunity to offer "kickbacks" until they are high up in an engineering firm. And the good and honest work they have done and have been taught to do as professional engineers at the drafting board or in the laboratory has not led them into the indicated unethical practices of certain members of the higher echelons of the engineering business. It may well be that there is little available evidence of corruption of any but the non-engineering employers or business representatives of engineers (who sometimes appropriate the name of consulting engineers)—men who have been so long away from the wholesome discipline of nature's laws and so exclusively concerned with the business of making money (and reducing their taxes) as to have become—as some others are reputed to be in commerce and law —ripe for rottenness and, at last, the bad apple in the barrel to spread corruption.

This article appears in the *Journal of Engineering Education* whose readers are mainly teachers in engineering schools. What can we pedagogues do about unethical practices that are so contrary to our teachings and, apparently, are learned long after college mainly by certain members of the more elevated brass. Frankly I do not know. My only thoughts are that we should constantly reexamine our own

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behavior as engineers and remove every trace of evil that we may find, reemphasize our ethical convictions in all our teachings and then *stick to our task of educating professional engineers* rather than to try also to produce practical men of business. By professional engineers I mean those with the high skills, advanced knowledge, and the earnest desire and firm will to do the best and most economic job. By practical men of business I mean men who have learned to "adjust" to the ways of the world and whose primary motivation, by their own admission, is profit rather than performance. The engineer must be taught to understand and then to *resist* the allurements of easy money and to stand firm against the threats of loss of a job to which engineers have always been subjected by promoters and politicians—by the former no less than by the latter and in "business" administrations as in any others.

Review of Current Research Available . . .

You can now get your copy of the "Review of Current Research and Directory of Member Institutions," published by the ECRC, which is just off the press. This is a complete directory of research projects in engineering colleges throughout the country. For a copy write to Professor Virgil Neilly at Pennsylvania State College, State College, Pa. The price is $2.50.

In Memoriam—H. P. Hammond

Dr. Harry P. Hammond, who retired on Sept. 1, 1951 as dean emeritus of the School of Engineering at The Pennsylvania State College, passed away on October 21, 1953 at the age of 68.

Recognized as one of the leading figures in the field of engineering education in the country, Dean Hammond during his 14 years at Penn State won two of the top national engineering awards. In 1945 he was presented the Lamme Award, the highest honor in engineering education, while in 1950 he was given the James H. McGraw Award in Technical Institute Education by the American Society for Engineering Education. Last June he was one of two leaders in engineering education to be named honorary members of the Society, one of the few times the honor had been conferred in the 61-year-old history of the Society.

Dean Hammond was named to the faculty at Penn State in 1937 to succeed the late Robert L. Sackett as dean of the School of Engineering. During his years as dean, the School of Engineering was built from a school with 1,000 students to one with more than 2,500 students. The research program also made tremendous gains with the addition of the Ordnance Research Laboratory as well as other programs so that today Penn State ranks high among the colleges of the nation in funds budgeted for research in engineering.

Physical facilities of the School also expanded during Dean Hammond's years on the faculty. The Electrical Engineering Building was completed in 1939 and the Civil Engineering Surveying camp was constructed in 1940. The Climatometer of the Department of Engineering Research was built in 1942, the Ordnance Research Laboratory and its Moshannon Field Station completed in 1945, and the Garfield Thomas Water Tunnel was opened in 1950. New units to the Mechanical Engineering Building were started prior to his retirement.

Dean Hammond's career as a practicing engineer included experience with the American Bridge Co., the Board of Water Supply of the City of New York, the Miami Conservancy District, and the firm of consulting engineers of Lederle and Probost. His field of specialization was sanitary engineering and structures.

During World War II, Dean Hammond served as a member of the National Advisory Committee of Engineering Defense Training and was in charge of the inspection of Army Specialized Training program units in the Third Service Command.

Dean Hammond served also as a specialist in higher education, making surveys of engineering education in Georgia, Missouri, Brown University, Cooper Union, Catholic University, and Virginia State College, and as chairman of a panel of the Service Academy Board for the U. S. Military Academy and the U. S. Naval Academy. He was chairman of the committee of the American Society for Engineering Education which submitted what are considered as the two most fundamental reports on educational policy in recent years, the reports on the Aims and Scope of Engineering Curricula and on Engineering Education After the War.

From 1924 to 1927, Dean Hammond was associate director of a comprehensive study known as the "Investigation of Engineering Education," which was sponsored by the American Society for Engineering Education. He was an active member of the organization, serving as vice-president in 1934–35 and as president in 1936–37. He was one of the organizers of the Engineers Council for Professional Development and also helped to organize and served until last year as chairman of the Council's Committee on Technical Institutes.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
*Allegheny	University of Pittsburgh		W. I. Short, University of Pittsburgh
Illinois-Indiana	Illinois Institute of Technology	May, 16, 1954	R. G. Owens, Illinois Institute of Technology
Kansas-Nebraska	Kansas State College	Oct. 9–10, 1953	M. H. Barnard, University of Nebraska
Michigan	University of Michigan	May 8, 1954	F. L. Schwartz, University of Michigan
Middle Atlantic	University of Pennsylvania	Dec. 5, 1953	C. Bonilla, Columbia University
Missouri-Arkansas	Missouri School of Mines	April 10, 1954	V. J. Blum, St. Louis University
National Capital Area	Library of Congress	Feb. 2, 1954	C. H. Walther, George Washington University
New England	University of Vermont	Oct. 10, 1953	E. T. Donovan, University of New Hampshire
North Midwest	Marquette University	Oct. 9–10, 1953	A. B. Drought, Marquette University
Ohio	Ohio State University	May 1, 1954	R. S. Paffenbarger, Ohio State University
Pacific Northwest	Oregon State College	April 23–24, 1954	L. Slegel, Oregon State College
Pacific Southwest	San Jose State College	Dec. 29–30, 1953	C. M. Duke, University of California at Los Angeles
*Rocky Mountain	University of Utah		A. Diefendorf, University of Utah
Southeast	North Carolina State College	March 25–27, 1954	J. R. Cudworth, University of Alabama
Southwest	University of Texas	April 16–17, 1954	J. J. Heimerich, University of New Mexico
Upper New York	Rochester Institute of Technology	October 16–17, 1953	F. E. Almstead, State University of New York, Albany

Members of the Society are welcome at all Section Meetings

* No Date Set.

Teaching Positions Available

The following rules were adopted by the General Council of the ASEE:

The privilege of advertising for teaching positions is extended only to colleges and technical institutes which are either Active or Affiliate Institutional Members of the ASEE. Advertisements must be for positions available only. No advertisements will be accepted for an individual seeking a job.

Advertisements must be submitted not later than the first day of the month preceding the month of issue. Because of limited staff, the ASEE headquarters cannot maintain personnel files or supply detailed information about jobs. In replying to blind ads, address letters to American Society for Engineering Education, Northwestern University, Evanston, Illinois and give blind ad number. Information and rates for advertising in the Journal can be received by writing ASEE Headquarters. In order to conserve space and achieve uniformity, the privilege is reserved to rearrange advertisements.

INSTRUCTOR OR ASSISTANT PROfessor, to Teach in the Field of Machine Design. M.S. and practical experience desirable. New building with excellent teaching facilities and opportunity for research. Reply to: V. M. Faires, Mechanical Engineering Department, North Carolina State College, Raleigh, North Carolina.

ASSISTANT PROFESSOR—TO TEACH Airplane Design, Aircraft Structures, and related subjects in the Aeronautical Option in Mechanical Engineering Department. Applicant should have Master's Degree or equivalent experience in aeronautical field. New building with excellent teaching facilities and opportunity for research. Application should be sent to Professor Robert M. Pinkerton, Mechanical Engineering Department, North Carolina State College, Raleigh, North Carolina.

INSTRUCTOR OR ASSISTANT PROfessor of Electrical Engineering (Power). At least B.E.E. required. Appointment immediately or February, 1954. Apply to Dean, School of Engineering, University of Virginia, Charlottesville, Virginia.

INSTRUCTOR OR ASSISTANT PROfessor in Civil Engineering, preferably with M. S. degree and practical or teaching experience; major interest—fluid mechanics. Position open fall, 1954. Department of Civil Engineering, Rose Polytechnic Institute, Terre Haute, Indiana.

INSTRUCTOR OR ASSISTANT PROfessor of sanitary engineering: M.S. desired, but not required; to teach undergraduate sanitary engineering courses and to do research in sanitary industrial fields; eleven months service. Position available anytime before February 1, 1954. Apply to Chairman, Department of Civil Engineering, State College of Washington, Pullman, Washington.

INSTRUCTOR OR ASSISTANT PROfessor of Electrical Engineering. Prefer one with interest in power. At least M. Sc. desired, or possibility of obtaining same soon. Position available immediately, or February 1st. Salary depends upon experience. Send application to Chairman, Department of Electrical Engineering, University of Nebraska, Lincoln, Nebraska.

Report of ECAC Manpower Committee

The following is a report of the ECAC Manpower Committee based upon surveys of industry and data obtained from the U. S. Office of Education.

Current Needs for Engineering Graduates

Unfortunately, returns from the Survey of Industrial and Governmental Organizations have been delayed unexpectedly, primarily because a request for salary information was included on the questionnaire. Returns thus far, therefore, do not justify definite conclusions concerning the magnitude of this year's demand. The attached table gives merely preliminary results from information received from a few industrial groups, where the sample is sufficient to have some reliability.

In general, the companies responding thus far include a distinctly higher proportion of small organizations than last year, in part, at least, because an effort was made to get more adequate coverage from them.

Other information in the table refers primarily to requirements from the current classes. Information was also requested concerning needs from earlier classes, but since they will be filled with men from other organizations, no report is made concerning them here.

In view of the smaller class this year, it is natural that the 1952 expected employment should be less than the 1952 actual employment. On the other hand, 1953 requirements are one-third more than the expected employment.

You will recall that the 1952 survey indicated a demand for about 40,000 new graduates, with about 25% of it coming from civilan government agencies. The tentative conclusion may be drawn from these data that the industrial demand this year will be of the same order of magnitude. We do not yet have sufficient data from governmental agencies to justify the conclusion concerning their demand, but it may be assumed from other evidence that it will be less than last year.

Supply of Engineering Graduates

The next table gives some estimates concerning the supply of engineering graduates for not only 1953 but other years in which classes now in college will graduate. Line 1 shows the number of bachelor's degrees estimated by Dr. Armsby of the Office of Education. The remaining figures use those numbers as a base, on the assumption that the number of men with graduate training becoming available will be roughly equal to the number of seniors entering upon such training. The notes on the table itself explain the methods used in making the estimates given. It is recognized that the actual situation will vary, possibly substantially, from that shown. Some of the men eligible for the draft or in the reserves will not enter military service, at least not immediately upon graduation. Not all of those who entered two years earlier will return, but within reasonable limits, some changes in one element of this picture will offset changes in another, and the final totals shown in Line 6 should be generally representative of the situation, assuming that announced policies concerning the drafting of men who have received student deferments are to continue. If they do not, the numbers available to industry in 1955 and 1956 will increase, perhaps substantially.

Demand vs. Supply 1953–1956

It seems clear that the shortage experienced last year will continue in 1953. There is some likelihood that the total demand may decrease in the next few years as the defense build-up activity tapers off, but these data would indicate that a substantial shortage will continue.

Possible Long-Term Situation

Any estimate of demand beyond the next few years is likely to be speculative. In 1951, the Bureau of Labor Statistics estimated a demand for not less than 30,000 during any period of partial mobilization, with a demand greater than that during the build-up period. It would be difficult to suggest any better figure today.

PRELIMINARY RESULTS

Need for Engineering Graduates in 1953

From Survey by Engineering Manpower Commission of Engineers Joint Council

Character of Sample Secured

	No. of Companies	% With Less Than 1000 Employees
1952 totals	380	21%
1953 to date	242	37%

Results for Selected Industries Only *

	No. of Companies	Total Engrs. Employed, Jan. 1	Required from Current Classes	Requirements as % of Engrs. Employed
1952 totals	156	77,201	11,358	14.7%
1953 to date	108	33,635	5,189	15.4%

From Current Classes

Ratio 1953 Expected to 1952 Actual Employment	Ratio 1953 Required to 1953 Expected
92%	133%

* Manufacturing industries: Machinery except electrical; electrical machinery, equipment and supplies; transportation equipment; chemical and allied products; petroleum and allied products.

Supply of Engineering Graduates

1953–1956

	Graduating Classes			
	1953	1954	1955	1956
1. Graduates	24,000	19,000	23,000	30,000
2. ROTC Commissions[a]	4,500	5,500	8,100	8,800
3. Draft eligible and Other Reserves[b]	7,200	7,100	9,900	14,100
4. Net for Industry, Education, and Civilian Government[c]	12,300	6,400	5,000	7,100
5. Returnees—Recent Graduates[d]	14,000	12,000	11,700	12,600
6. Totals for Industry, etc.	26,300	18,400	16,700	19,700

[a] Current Dept of Defense objectives.

[b] 1953—Engineering Manpower Commission Survey. 1954–6—Remainder after deduction of ROTC, veterans, and 4 F.

[c] 1953—derived directly from Lines 2 and 3; about ⅔ pre-Korea veterans and ⅓ 4 F. 1954–6—4 F (⅓ of non-ROTC and non-veterans)—veterans in 1954 only (15% of class).

[d] ROTC and draft eligibles 2 years previously.

As to future engineering classes, Dr. Armsby has recently studied this situation carefully and on the assumption that the proportion of the total freshman class enrolled in engineering in the fall of 1952 was somewhat greater than normal, he estimated a modest decrease from the 1956 figure of 30,000 followed by a graduate rise to at least that figure by about 1961. If the conditions which led to a large freshman class last fall continue, it is quite likely that no dip will occur and there will be a gradual and continuous rise.

DONALD S. BRIDGMAN, *Chairman*
June 22, 1953

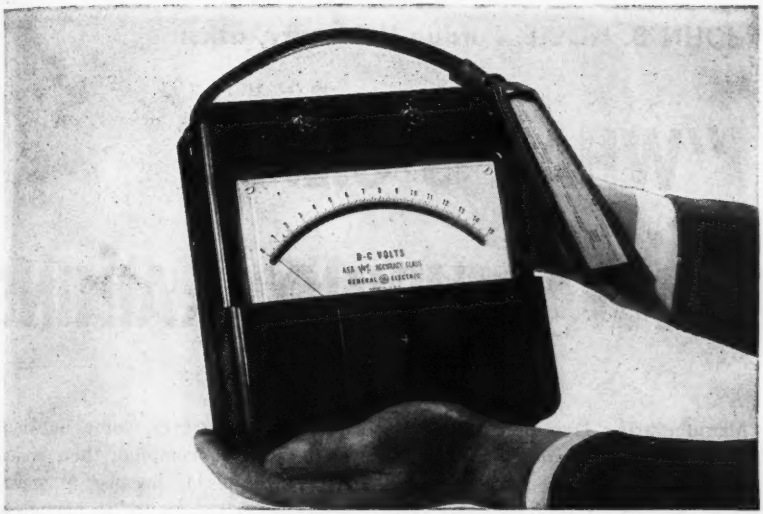
ANNUAL MEETING

June 14-18, 1954

University of Illinois **Urbana, Illinois**

Reprints Available . . .

Are you interested in receiving copies of the newly completed "Manual of Graduate Study" or the "Report of the Committee on the Improvement of Teaching"? Copies of these can be obtained from the Secretary's Office, the price of the Graduate Manual being 50¢ and that of the Report of the Committee on the Improvement of Teaching being 15¢ each or $8.00 per hundred. All orders should be accompanied by a check remittance.



General Electric announces new line of high-accuracy portable d-c instruments

HIGH-ACCURACY—General Electric's new DP-12 portable instruments feature accuracy of ¼ of 1% of full scale. For less critical applications new DP-11 instruments have an accuracy of ½ of 1% of full scale. Voltmeters, millivoltmeters, ammeters, milliammeters, and microammeters are available in a wide range of ratings.

STURDY CONSTRUCTION—spring-mounted jewel bearings provide for maximum protection against damage from shock. Strong, break-resistant extra heavy Textolite* case encloses the instruments.

BETTER SCALE ILLUMINATION—new molded window assures best lighting of the instrument's large 5½-inch wide-open scale for fast, correct readings.

IMPROVED TERMINALS—terminals are located at the rear of the instrument, away from the operator. This arrangement provides both convenience and safety for the operator. New design accommodates a greater variety of connecting leads.

Further information about General Electric's new DP-11 and DP-12 instruments may be obtained from your nearest G-E Apparatus Sales Office, or write for bulletin GEC-979, General Electric Co., Section 688-2, Schenectady 5, N. Y.

*Registered trade-mark, General Electric Co.

You can put your confidence in—

GENERAL ELECTRIC

JOHN B. NOLTE, Purdue University, asks:

"WHAT IS G.E.'s MANUFACTURING TRAINING

The Manufacturing Training Program at General Electric is a program of basic training for manufacturing leadership, including planned rotational work assignments and related classroom study for outstanding young men who are interested in a career in manufacturing. It was organized to meet the increased demand for effective manufacturing leadership and technical "know how," in line with the expansion and development of the Company's operations by developing trained men to fill future key positions in the organization.

Who is eligible for this program?

In general, the Program is open to college graduates with degrees in engineering and science, and a limited number of business administration and liberal arts graduates. We are looking for outstanding young men with sound educational backgrounds, well-balanced personalities, demonstrated thinking abilities, and having the potential to develop toward top level responsibility in key assignments.

How long is the program?

The normal length of the Program is three years. However, some individuals may be able to complete their training in a shorter period because of previous knowledge or experience in manufacturing work.

What type of work assignments are made?

Work assignments are provided in all phases of manufacturing and related functions so that each man will acquire knowledge of manufacturing engineering including manufacturing methods and techniques, shop operation, production control, personnel administration, labor relations, engineering activities, sales and manufacturing co-ordination, and general business administration.

In addition to job assignments, classroom courses cover such subjects as Company organization, manufacturing operations, labor and personnel relations, business administration, law and relationships between manufacturing and other functions of the business. Progress on the job and in classroom work is carefully observed and reviewed periodically with each man to assist him in his career.

PROGRAM?"

What happens after training is completed?

After completing the training program, graduates are placed in operating departments and divisions throughout the Company in positions where leadership and initiative are needed. All placements are made in relation to the aptitudes, abilities, and interests of the graduates.

At General Electric, manufacturing operations involve the administration and supervision of activities of more than 100,000 men and women in more than 100 plants, who are involved in the making of some 200,000 different products.

The wide scope of these activities, the great variety of products, and the diversity of manufacturing activities offer limitless opportunities and exciting challenges to college graduates today.

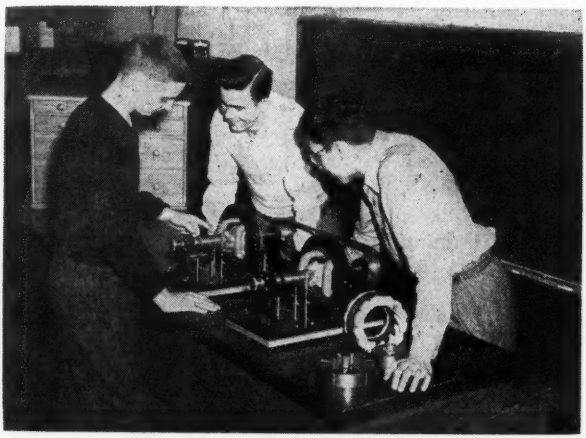
Manufacturing training is a foundation for leadership—and an opportunity to build a satisfying, rewarding career in one of America's most important industries.

If you are a graduate engineer, or a graduate with definite technical inclinations that include an interest in the career possibilities in manufacturing, see your college placement director for the date of the next visit of the General Electric representative on your campus. Meanwhile, for further information on opportunities with General Electric write to College Editor, Dept. 2-123, General Electric Company, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

CROW ROTATING ELECTRIC MACHINE



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Boeing offers graduates

ENGINEERING CAREERS *with a future*

When you counsel students, you want to guide them toward careers that offer opportunities for advancement, for varied experience and stability. Boeing fulfills *all* these requirements. For no industry approaches this one in offering young engineers such a wide range of experience, or such breadth of application—from pure research to production design, all going on simultaneously.

STABILITY

Boeing is in its 36th year. Its Engineering Division, which has grown practically continuously, now numbers over 6000, in contrast to a peak of 3500 at the height of World War II. Aircraft development is such an integral part of our national life that young engineers can enter it with full expectation of a rewarding, long-term career. While the Boeing Engineering Division is large, it is so organized that each engineer is an individual who stands out in proportion to his ability.

BREADTH OF EXPERIENCE

Boeing is constantly alert to new techniques and materials—and approaches them without limitations. Extensive sub-contracting and major procurement programs – directed and controlled by engineers – afford varied experience and broad contacts and relationships.

PRODUCTS

Boeing produces C-97 military transports, B-47 six-jet and B-52 eight-jet bombers. Through these fighter-fast jet bombers, Boeing has acquired an unmatched background in designing, building and flying multi-jet aircraft. It is the first American company to announce entry into the jet transport field. In addition, Boeing conducts a comprehensive guided missile program, research on nuclear-powered aircraft, and produces a revolutionary gas turbine.

RESEARCH

Boeing's research facilities are unsurpassed in the industry. They include America's only privately designed and owned trans-sonic wind tunnel, and acoustical, hydraulic, pneumatic, mechanical, electronics, vibration and physical research laboratories.

OPENINGS

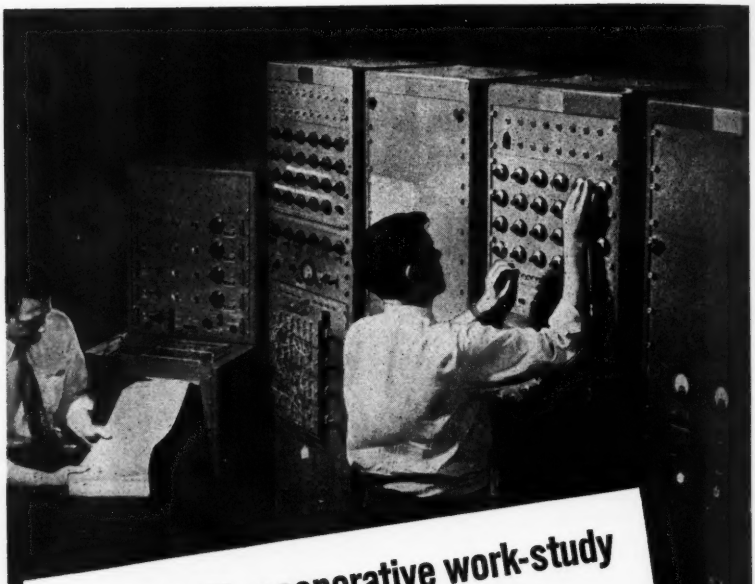
Openings for graduates at Boeing lie in *all* branches of engineering, for work in aircraft designing, development, production, research and tooling. Also for servo-mechanism and electronics designers and analysts, and physicists and mathematicians. Boeing engineers work at engineering. The division is so organized that most drawings are made by draftsmen.

LOCATION

Boeing engineering activity is concentrated at Seattle in the Pacific Northwest and Wichita in the Midwest. In addition to skiing and mountain sports near Seattle, both communities offer fine fishing, hunting, golf, boating and other recreational opportunities. Both are fresh, modern cities with fine residential and shopping districts, and schools of higher learning where engineers can study for advanced degrees.

INFORMATION

If you or any of your students would like additional information about engineering careers at Boeing, write to John C. Sanders, Staff Engineer-Personnel, Boeing Airplane Company, Seattle 14, Washington.



Honeywell's cooperative work-study program for college students

New ideas in basic and applied research are the result of the integration of education and experience.

The Cooperative Work-Study Plan was developed at Honeywell to aid students in getting valuable experience in basic and applied engineering. College students in training under the plan begin their sophomore year by working at Honeywell. Then, until graduation from college, the student-engineer alternates for equal periods between Honeywell and college.

In addition to this excellent training and valuable experience, the Cooperative Work-Study Plan allows the student an opportunity to continually evaluate his educational goals. Occasionally a student may, on the basis of actual contact with his plant responsibilities, redirect his vocational goal.

For more information on the Honeywell Cooperative Work-Study Training Program, write Mr. Howard Mold, Director of Training, Minneapolis-Honeywell, Minneapolis 8, Minnesota.

MINNEAPOLIS **Honeywell**

First in Controls

Serendipity
and the
engineering graduate

"Serendipity" is not just the multisyllable jawbreaker whose successful spelling won a recent national spelling contest.

It's a pretty good definition of what can happen to a young engineering graduate with ambition who hitches his job wagon to the General Motors star.

For "serendipity" is "the gift of finding valuable or agreeable things not sought for."

And many a top executive at GM has found a valuable and agreeable career far removed from what he planned when he first started at General Motors.

So many and diverse are the activities at General Motors, so great is the respect for the brain which can comprehend and the character that can tackle problems way beyond those for which the person was originally trained —that a young GM engineer can often smilingly say: "I don't know where I'm going but I'm on my way."

Or as Mr. Charles A. Chayne, Vice-President in charge of Engineering Staff phrases it:

"The General Motors engineering force is deployed throughout the organization and performs tasks that apply the fundamentals of nearly every branch of engineering that is taught in the nation's classrooms. Many of these men (ed. note "here's where serendipity comes in") as they gain experience, will move into positions for which there is no specific university training ground—such as general management responsibilities."

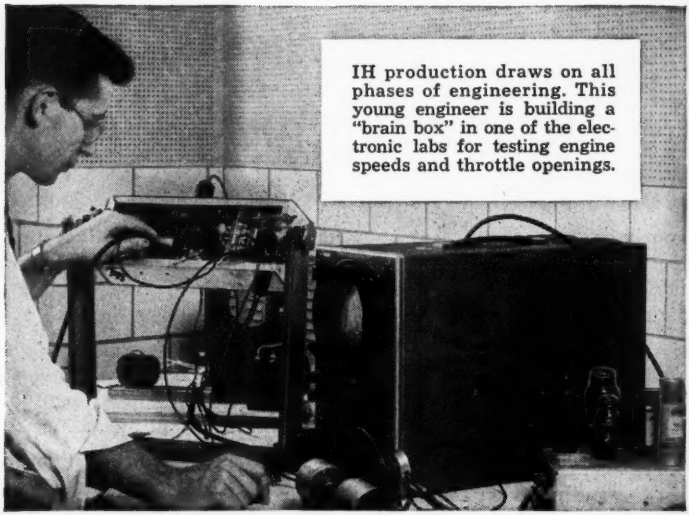
How are your students on "serendipity"?

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

"BRAIN BOX" NEEDS BRAINS

Invest your education in industrial production



IH production draws on all phases of engineering. This young engineer is building a "brain box" in one of the electronic labs for testing engine speeds and throttle openings.

■ International Harvester has long been associated with leadership in new and improved products that increase productivity of agriculture . . . that improve transportation . . . that protect and preserve food through refrigeration. Not only does the Harvester engineer invest his education in a sound, well-managed, progressive company that pays excellent dividends in opportunity but he is a key figure in helping to supply the tools that underwrite the production facilities of the nation's most vital industries.

Today there are more research and engineering projects under way than ever before in International Harvester's history. We need engineers for training programs as well as for regular engineering positions in mechanical, industrial, metallurgical . . . *in all phases of engineering!* We suggest you write to F. D. MacDonald, Education and Personnel Department, International Harvester Company, 180 N. Michigan Avenue, Chicago 1, Illinois.

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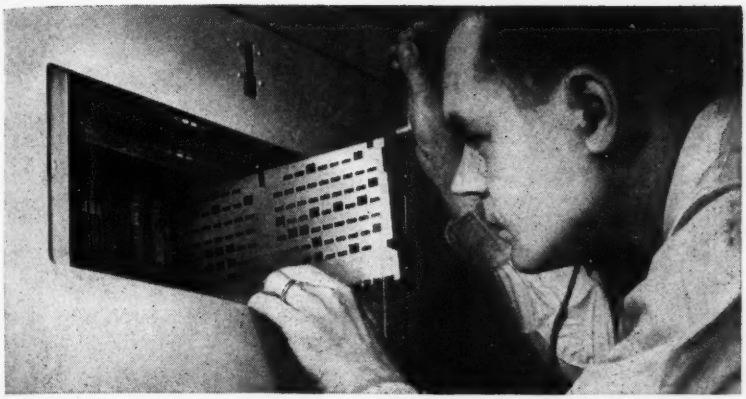
Builders of farm equipment for easier, more profitable farming . . . trucks for better transport . . . industrial power for road-building and earth-moving . . . refrigeration for better preservation of food



Checking perforated metal card in Bell's new "card file." If the first voice-way is in use, a "detour" is swiftly found.

CARDS FOR CONVERSATION

To find out how to route Long Distance calls a dial system needs lots of information – fast. To provide it Bell Laboratories engineers developed a new kind of card file – one that dial systems can read.

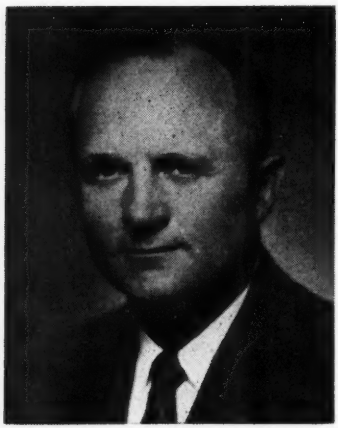
Punched holes on metal cards tell how calls should be handled. When a call arrives the appropriate instruction card is displaced so that its pattern of holes is projected by light beams on a bank of Phototransistors, which signal switches to set up the best connection.

The "card file" will have its widest use in speeding Long Distance calls that are now dialed by a telephone operator and may one day be dialed by you personally. It is another example of how Bell Telephone Laboratories helps telephony to grow, as costs are kept down.

New Phototransistor unit. Light entering cylinder is focused by lens on germanium that responds by generating current. Like the Transistor, the Phototransistor was invented in Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS.



A MESSAGE TO COLLEGE ENGINEERING STUDENTS

from R. S. Kersh, Vice-President, Northeastern Region, Westinghouse Electric Corp.

To the young engineer eager for a sales career

Show me an engineer with a friendly attitude, and an eagerness to help people solve their problems and I'll show you a good sales engineer.

There's nothing mysterious about this job of being a sales engineer. To apply the technical products of his company to his customer's needs, he must first be a good engineer.

To gain the confidence of his customers he must be a good salesman. This means simply that he should have an inquisitive nature, the desire to help others, and the quality of enthusiasm.

The Westinghouse sales engineer works with our design engineers, production engineers and engineering departments of our customers. He is a highly important and valued professional man.

What are the opportunities at Westinghouse for a young man eager for a career in sales? They are just about what you want to make them! This company's 30 divisions make over 8,000 products, totaling over $11\frac{1}{2}$ billion in sales annually. Westinghouse is looking to the future with a vast expansion program. We are a fast-growing company in the dynamic field of electrical energy.

If your sights are set on a sales career, I am sure you will find the training and opportunity you seek with Westinghouse.

For information on career opportunities with Westinghouse, write: Educational Department, Westinghouse Electric Corp., East Pittsburgh, Pennsylvania.

YOU CAN BE SURE...IF IT'S Westinghouse

This advertisement appears in College Engineering Magazines

Message for

Student Counselors

Allis-Chalmers Offers Your Graduates a Unique Opportunity

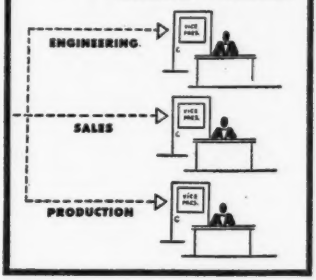
Your engineering graduate can get firsthand experience in nearly every industrial operation during his time on the Allis-Chalmers Graduate Training Course.

He can broaden his knowledge and viewpoint working on major equipment for electric power, mining, cement, agriculture, food and chemical processing, steel and many other industries. By the time he finishes the course, he is in the best possible position to make a success of his career in the industrial field of his choice.

Be sure that your engineering graduates are informed about the unique opportunity available at Allis-Chalmers.

The Right Job for the Right Man

. . . Unlimited Potential!



FACTS . . . About Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic turbo-generators, circuit breakers, unit substations, transformers, motors, control, pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations, he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wis.

A-4025

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